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THE INSTITUTION MEETING, 1949

THE Annual Meeting of the Institution of Gas Engineers was held in the Great Hall of the Institution of Civil Engineers, London, on June 13 and 14 under the Presidency of Mr. Edward Crowther, Chairman of the Northern Gas Board. The duration of the meeting was curtailed in view of the 4th International Gas Conference of the International Gas Union, of which the Institution is a founder member, the Conference occupying the remainder of the week. We shall deal with this in a special issue of the *Journal* on July 6. Attendance at the Institution meeting was round about 800, and there were present an unusually large number of important visitors, including official delegates from the National Gas Associations of Belgium, Canada, Denmark, France, Holland, Italy, Norway, Switzerland, and the United States of America.

The meeting started at 3 o'clock in the afternoon of Monday, June 13, when Mr. Crowther offered a welcome on behalf of the Institution to the many distinguished engineers from overseas. The greetings of the old world, he remarked, were brought by M. M. A. J. Brabant, President of the Belgian Gas Association, and those of the new world were brought by Major Alexander Forward, one time managing director of the American Gas Association and an honorary member of the Institution.

At the invitation of the President, M. Brabant, in response, said he would like to have been able to express in correct English the cordial greetings and sincere good wishes of all the continental Gas Associations which were the guests of the Institution.

Speaking in French, he said he would like to express first of all the profound gratitude felt by the members of all the delegations from the Continent—Danish, French, Norwegian, Dutch, Swiss, Swedish, and Belgian—for the cordial and friendly way in which they had been received by their English friends. Not only did they have an opportunity to renew their friendship with their British colleagues, which was for them all a very great pleasure, but they would with great interest follow the papers and discussions. They did not forget that Britain went back to the beginnings of the gas industry, and that, ever since the illumination of Westminster Bridge by gas in 1813, England had always been in the van of progress. He added a special word of thanks to the Secretary-General, Dr. W. T. K. Braunholtz.

Major Alexander Forward said he was very happy indeed to meet members of the Institution once more, and to take the opportunity of expressing his appreciation of the honour which had been accorded him by the Institution in electing him an honorary member, a distinction which he shared in the United States with the distinguished gas engineer Dr. A. G. Glasgow. The American Gas Association was appropriately directly represented at the meeting by the President, Mr. R. W. Hendee, with whom he joined in bringing greetings

from all the officers and members of the American Gas Association for a happy and successful meeting. During his many years of service with the American Gas Association, relations with the Institution of Gas Engineers had always been happy, pleasant, and thoroughly co-operative.

Dr. Braunholtz announced that a telegram had been received from the National Gas Association of Australia and the Australian Gas Institute stating:

> 'National Gas Association, Australia, and Australian Gas Institute send greetings and best wishes successful meeting.'

At this stage in the proceedings the President moved the adoption of the 86th Annual Report of the Council of the Institution for 1948-49 and the Accounts for 1948.

I.G.E. New Headquarters

Dr. Harold Hartley, immediate Past President, seconded the motion. He remarked that it was now 13 months since the appeal for funds for the new headquarters of the Institution was launched officially. Members would recall that a target of £110,000 had been set, which was sub-divided into £10,000 from members, £20,000 from the Society of British Gas Industries fund, and £80,000 from gas undertakings. The results obtained were very satisfactory. At June 7 the donations received and the promises made were such as should enable the Institution to receive the following sums:—From members, £10,954; from S.B.G.I., £27,015; and from gas undertakings, £74,928, which totalled £112,897. The sums actually received by that date and available for the purchase of the headquarters totalled £84,822. The Institution had acquired No. 17, Grosvenor Crescent, which was 100 yards approximately. from Gas Industry House and almost on the corner of Belgrave Square. The rooms in the premises on the four floors totalled a floor area of about 7,000 sq.ft. The price of the 51 years' unexpired lease was £42,500, and there was a ground rent of £450 a year.

Election of Officers

The report of the scrutineers of the ballots for the election of officers, auditors, and ordinary members of Council was as follows:—

President, 1949-50: Cecil Harry Chester, O.B.E., Chairman, South Western Gas Board.

Vice-President, 1949-51: John Horsfall Dyde, M.Sc., Deputy Chairman, Eastern Gas Board

Auditors, 1949-50: Harold Charles Smith, C.B.E., D.L., J.P., Deputy Chairman, the Gas Council, and Ernest D. Davey, F.C.A., Wood, Drew and Co.

Hon. Secretary, 1949-50: John Terrace.

Ordinary Members of Council, 1949-52: Alexander George Grant, M.Sc., Director and General Manager, Whessoe, Ltd.; James MacLusky, District Engineer and Manager, Halifax Gas Undertaking, North Eastern Gas Board; William Kenneth Tate, M.A., Manager, Eastern Division, Southern Gas Board; and John Ellis Wakeford, M.B.E., Manager, Birmingham Division, West Midlands Gas Board.

The election was then announced of honorary members, members, associate members, and associates (see p. 709).

The President said that the list of honorary members was as short as it was distinguished, and in adding to it the names of Mr. A. E. Sylvester and Colonel H. Zollikofer, an addition had been made equally to its length and distinction. Mr. Sylvester, he continued, who was soon to be known under another style and title, was very well known, and the Institution offered him warmest congratulations and good wishes upon the Knighthood of the Order of the British Empire which His Majesty was to confer upon him. The gas industry of Great Britain was proud that its most senior representative should be thus honoured..

Those who knew Colonel Zollikofer best esteemed him most highly. His whole lifetime had been devoted to the gas industry, which he had served in many capacities. Son of a gas engineer, Colonel Zollikofer studied under Professor Munthe, and thereafter held successive appointments of increasing importance in the gas industry of Switzerland. Later he joined the National Technical Association of his country, in due course becoming its Secretary. In that position he had vastly increased the usefulness of the Association itself, and had contributed much to its technical literature. Some 12 years ago he was elected the Secretary-General of the International Gas Union, and his work in that capacity had been of the first importance.

The Golden Mean

Mr. A. E. Sylvester, in reply, said it would be impossible for him to pretend that he was not very deeply touched by the great honour which had been conferred upon him, and by the kind words uttered by the President. Most people found that life was full of ups and downs. One moment an individual was on top of the waves and everybody spoke well of him, and the next moment he found himself in the trough where he received a number of kicks. The wise man tried always to remember that there was a general level and endeavoured to strike a happy medium. It was a source of great gratification to himself that the Institution had seen fit to honour him by electing him an honorary member. The word 'honorary' had, so to speak, a double significance. One was, of course, that he was not expected to become or it was not assumed that he would suddenly become skilled at engineering matters, for his worst enemies would not accuse him of being an engineer; but he did realise that in the gas industry engineers really did matter, and the industry, obviously from its very nature, could not have been developed without the Institution of Gas Engineers.

Colonel Zollikofer thanked the President and members of the Institution for the great honour which had been conferred upon him. When the President honoured the Swiss Gas Association in 1948 with his presence at their meeting, the speaker never expected to be made an honorary member of the Institution. He accepted it as a token of the cordial relationship which existed between the Institution and the Swiss Association, and his election would always bring to his mind the close personal collaboration he had enjoyed with Colonel Croft, the esteemed President of the International Gas Union, who honoured him with his confidence during the three years of his office, and with Dr. Braunholtz, whose excellent and invaluable work for the international gas industry would never be forgotten.

The President said he desired personally to congratulate Mr. Chester on his election to the Presidency of the Institution, and invite him to say a few words.

Mr. C. H. Chester, O.B.E., Chairman, South Western Gas Board, in reply, said that it was indeed a great honour to be elected President of the Institution of Gas Engineers. He was a little hesitant at taking on the Presidency of the Institution at such a vital time in the affairs of the industry; but he felt sure that he could count on the hearty co-operation of the Gas Council.

District Members of Council

The following were elected District Members of Council: J. D. Ashworth (Blackburn; Manchester), J. H. Fulton (Haddington; Waverley), C. E. Grimwood (Sudbury; Eastern), L. P. Ingram (Taunton; Southern), D. W. Rees (Pembroke Dock; Wales and Monmouthshire), S. J. Sadler (Solihull; Midland), R. Sturrock (Ardrossan; North British), G. Walmsley (Londonderry; Irish), G. G. Warne (Portsmouth; British Junior Gas Associations Joint Council), F. Wilson (Darlington; North of England).

This brought us to the presentation of the following medals:

Institution Gold Medal, 1948—to H. J. Escreet, B.Sc. (Eng.), M.I.C.E., M.Inst.Gas E., for his paper on 'A Survey of Gas Distribution Practice,' read at the 85th annual general meeting of the Institution of Gas Engineers in London in 1948.

H. E. Jones London Medal, 1948—to T. C. Finlayson, M.Sc., M.I.Chem.E., M.Inst.Gas E., and F. S. Townend, B.Sc. (Eng.), M.Inst.Gas E., for their joint paper on 'Gas Production in Perspective,' read at the 1948 meeting.

Institution Silver Medal, 1948 — to J. A. Tomes, M.Inst.Gas E., for his paper on 'The Application and Potentialities of Town Gas in the Hand Blown Domestic Glass Industry,' read at the autumn meeting of the Midland Association of Gas Engineers and Managers in 1948.

Institution Bronze Medal, 1948—to J. A. Williams, M.Inst.Gas E., for his paper on 'Laying a Gas Main in the

The photograph at the foot of the opposite page gives a striking impression of the Great Hall of the Institution of Civil Engineers at the opening meeting. Left, our Staff Photographer records the President as he rose to welcome visitors from overseas. One such distinguished visitor was Mr. R. W. Hendee, pictured below, during the course of his address later in the afternoon.

Sea,' read at a general meeting of the London and Southern Junior Gas Association in 1948.

Presidential Address

Mr. Crowther then delivered his Presidential Address (published in full, p. 700 *et seq*).

Mr. N. Hudson, in proposing a vote of thanks, said he would not be strictly honest if he said that the excellence of the address had surprised him. It would be more true to say that the 'Crowther standard' had been maintained on yet another occasion. He had had the happy privilege of knowing the President for some 20 years, and he well remembered the impression which he created among his confrères in Yorkshire when he first represented the Bradford undertaking. It was soon accepted by all that, given good health and a modicum of good fortune, he would eventually occupy the highest position within the industry. It was fortunate that his health had stood the strain of the past 12 months, for no man had, he ventured to suggest, occupied the Presidential Chair in more strenuous times—in times when it appeared humanly impossible to complete all the work which fell to the lot of a leader in his profession and in the industry which he served. Somehow, possibly at the sacrifice of nearly all his leisure, the President had fulfilled all his duties, and his address provided evidence of the fact that he had also found time to study, very seriously, present day problems and was prepared to accept them as a challenge. He had reviewed the position of the Institution itself, briefly examined its past achievements, and then indicated to each member the steps which the Council were taking to ensure that the services of the Institution would be of even greater significance to its members in the future than in the past. In that connection it was only right that every member should study carefully all that was being done, and determine to play his full part in assisting the President and the Council to achieve their objectives. Secondly, he had brought forcibly to the notice of members one or two of the chief problems of today in the art and science of gas engineering—problems which at first sight seemed separate and distinct, but which in reality were so conjoined that only by wise compromise could a satisfactory solution be resolved They were problems which, however one would wish it otherwise, demanded that the interdependence of the science of gas manufacture and distribution and the science of commercial buying and selling should be recognised. The President followed his review with suggested lines of attack, which, along with the ideas of other thinkers, must be studied if the industry was to maintain and, if possible, improve its ability to meet the demand of the nation for its products. Lastly, the President considered research. He asserted that the gap between the scientist and the engineer was too wide and that there was need for a liaison staff between the two so that the implications of the work already done by the scientist might be the more readily appreciated by the engineer. It was, indeed, surprising how much research had already been done on nearly every problem which confronted the industry at the present time, and again it was a fact that in many instances research effort in the industry was unnecessarily duplicated. Surely then, any liaison such as that suggested by the President could not help but be beneficial to the industry both as a time and a money saver.

Mr. F. W. Sansom, M.B.E., in seconding the vote of thanks, said that Mr. Crowther had, indeed, been a distinguished President, and that he had been able, especially during recent months, to devote himself so wholeheartedly to the affairs of the Institution in addition to the many duties which must devolve upon him as Chairman of the Northern Gas Board, put members in a position of special indebtedness to him. The address was one especially attuned to the needs and conditions of the present time and was typical of Mr. Crowther's keen insight and clear perception. Members were grateful to him for so clearly defining the functions of the Institution within the framework of a changing gas industry. In his survey of the industry under national ownership, he had drawn attention to certain problems as being worthy of consideration. It might be suggested that the true interpretation was that those problems were worthwhile subjects for papers, and that Mr. Crowther was, with typical modesty, giving a definite lead for the future. The problem of plant capacity for peak loads was a subject of vital importance to the industry, and it was felt that the paper which the Institution was privileged to receive from the President of the American Gas Association might serve to underline Mr. Crowther's remarks and to stimulate further consideration of that problem.

Peak-Load Problems in U.S.A.

Mr. Crowther said that the meeting was privileged to receive a paper on a subject of major importance, entitled 'Peak-Load Problems in the United States.' The interest of this paper, which was sponsored by the American Gas Association, was greatly enhanced by the fact that it was to be presented by the President of the American Gas Association in person. The members of the Institution greatly appreciated his presence among them. The experience of their American colleagues with peak loads developed somewhat earlier and more rapidly than their own; but, convinced as he was that they must be prepared to meet comparable problems here, it was most helpful to benefit by an account of their incidence in America and of the steps taken to cope with them. As an instance of the growth of the heating load he might mention the case of Boston, which, with an annual sale equal to that of Newcastle, had a maximum daily send-out one and a half times as great. The Council of the Institution endeavoured, shortly after the war, to arrange an exchange of personnel with the American Gas Association, thus anticipating in some degree the work of the subsequently-established Joint Council. Although not immediately successful in this, they had kept in touch with developments, and the paper now to be presented would provide another most acceptable and opportune contact with their American colleagues. It was therefore with very great pleasure that he introduced Mr. Robert W. Hendee, President of the Inter-State Gas Corporation of Colorado and President of the American Gas Association.

Increasing Plant Capacity

Mr. Hendee then read his paper entitled 'Peak-Load Problems in the United States (see p. 703). In doing so, he mentioned that he was what might be described as 'a natural gas man.' He had been brought up in the natural gas industry, and had been in that industry all his life. Although in the paper he dealt with all the methods of meeting peak loads, he felt that natural gas was the answer in America to all their peak-load problems. It was his opinion that natural gas would reach all the corners of the United States, and that in some way or other it would serve to meet the peak loads. Dealing with the solution of the peak-load problem by the adaptation of existing plants, he said that the Hall High B.Th.U. process was being employed to a considerable extent at the present time, and had been found extremely useful in increasing the capacity of various plants. He also mentioned that the use of liquefied petroleum gases was being used a great deal in industrial plants, and said that some very large installations had been made. Dealing with underground storage in the Appalachian region, he remarked that he would have liked to be able to go into that matter more fully, because it was wonderfully interesting and of tremendous value to the companies in the Appalachian area. Hundreds of abandoned gas fields were being built up again with natural gas, which was used during the peaks. Referring to the liquefaction of natural gas at low temperature and low pressure and its storage to meet peak

conditions, he mentioned that since he left the United States the Chicago system had been augmented by a plant of this type with a capacity of 300 mill. cu.ft. in spherical tanks above ground.

Discussion on Mr. Hendee's paper brought Monday's proceedings to a close.

Nationalisation and the Individual

On the Tuesday morning the President, in introducing Mr. Sylvester, said that the satisfaction which the Council felt that Mr. Sylvester had accepted an invitation to address the meeting was shared by all those present. At the request of Mr. Sylvester, the programme gave no indication of the subjects upon which the author intended to touch, so that the interest and attention with which his communication was awaited and which his abilities and high office in the industry commanded were heightened by the absence of any advance information. While it might be difficult for Mr. Sylvester on such an occasion to dissociate himself from his capacity as Chairman of the Gas Council, at the same time, members would assume that he was speaking—unless he expressed a wish to the contrary—in his personal capacity. The Institution felt itself fortunate in being able to offer to those in high places a platform from which they might express their personal views and opinions, and everyone present would be particularly glad to know Mr. Sylvester had the platform on this occasion.

Mr. Sylvester then gave his address (p. 710).

Dr. Harold Hartley, in moving a vote of thanks, said that he was sure Mr. Sylvester would appreciate, from the very close attention that had been paid to his address, that the session had been awaited with a great deal of interest. Any remarks which the Chairman of the Gas Council might make on such an occasion would deserve and would always receive most careful consideration by the members of the Institution. When it happened, however, as in the present instance, when the holder of that office was one who had been known and respected for many years by the members of the Institution, their approach to anything that he might suggest was that of people already half-persuaded. As the members had expected, the subject which Mr. Sylvester had chosen for his address was apt, and, again as the members had expected, his presentation of it had been thoughtful and interesting. It was always stimulating to listen to one of high intelligence developing a theme which he had at heart.

The Secretary of the nstitution, Dr. W. T. K. Braunholtz.

The rapid increase in scientific knowledge and its application by the engineer and other technicians, continued Dr. Hartley, was creating strains in the social structure, and those in their turn required change for their accommodation, so that there might be evolution and progress rather than revolution and chaos. It was fortunate that the people of this country were prepared to experiment to a large extent. It was to that, he thought, that they owed much of the recognition afforded to them by other peoples. He believed that willingness to experiment existed because at the root the majority of the people of this country were individualists, prepared to accept leadership only if, of their own free judgment, they felt it to be basically sound. It was because they were so fashioned that they were a democratic people, that they had evolved a means of operating their institutions in a democratic way, and that they judged a man not by his birth or other accidental attribute but by his deeds and his merit. It was an ideal of democracy that the affairs of the people should be managed so as to give first consideration to the individual. When that was done, conditions could be created to enable each to give of his best in his particular sphere of activity.

Mr. Sylvester had reminded the meeting that the gas industry was an old one, and, as he knew, some of the members had in the past given a lead in political development. The roots of the industry were spread wide and deep, and those now engaged in it had had handed on to them by their predecessors a fund of experience and wisdom. It was to groups such as the members of the Institution that the country looked and had a right to look for development.

The Start of a New Phase

Even if Mr. Sylvester were not Chairman of the Gas Council, his views as a specialist with an experience different from that of the majority of the audience would be accepted by their fellow members as of great value in helping to solve some of the problems which exercised their minds. He hoped Mr. Sylvester would in his turn agree that it was a sign of grace that the members enjoyed and appreciated the opportunity of hearing an exposition such as that with which he had favoured them on the present occasion.

Today the members of the Institution found themselves at the start of a new phase of progress and facing a future of great possibilities. They had reason to expect that their experience would broaden rapidly and that they would acquire a new conception of their responsibilities and a greater appreciation of their power to do good. With it all there would be a great need for social engineering. Before the change in the organisation of the industry, the concept had grown that there was a need for the grouping of undertakings as a means of ensuring a greater co-ordination of effort. Now that that had happened, it would be unfortunate, as Mr. Sylvester had emphasised, if the idea were to develop that as a consequence the individuals carried less responsibility. If anything, their responsibilities were likely to be greater, because they were members of larger teams, whose actions had greater power for good or ill. That there might be greater gains and greater honours for the individual was incidental. Greater responsibility was unavoidable.

Thinking people in all walks of life realised that to a certain extent they must conform to a pattern, but, he submitted, they conformed to the pattern only so long as the pattern did not offend their individual idea of what was right and just. As soon as they felt that a change was needed in order to keep in line with altering conditions of life, their individuality began to reassert itself. The history of industrial development in this country in the last few years served to stress the importance of individual effort. It was only when people could make full use of their intelligence that they were able to give of their best and to feel that sense of invigoration which made life so full and fine a thing.

He thought it would have been difficult for Mr. Sylvester to select a theme for his address which would have proved more salutary than the one which he had chosen. On Mr. Sylvester's leadership and guidance much would depend in the next few years. In showing the members, as he had on the present occasion, something of the working of his mind, he had done a great deal, because he would thus increase

the confidence already felt in him by the members of the industry, who had welcomed sincerely the announcement last year of his appointment to the headship of the industry.

Mr. S. E. Whitehead, J.P., Deputy Chairman of the Southern Gas Board, in seconding the vote of thanks, endorsed Dr. Hartley's remarks in regard to the gratitude of the members to Mr. Sylvester, who had placed them under a still further obligation by his masterly and encouraging address. Apart from its high literary character, the address was full of very hard thinking and sound common sense. It would form a valuable contribution to the Institution's *Transactions* and would be read and re-read by the members.

Mr. Whitehead, continuing, said he was sure that all present had been impressed by the fact that Mr. Sylvester had laid stress on the importance of the individual. That was a strong argument in favour of decentralisation. In the area in which he (the speaker) had the honour to serve and, he believed, in many of the other areas, decentralisation was being practised as far as possible, and he was quite sure that that was a sound policy from every point of view. It had been emphasised and approved strongly by the Chairman of the Gas Council, who had given the subject a tremendous amount of thought, and it was most encouraging to know that he believed in decentralisation. Decentralisation must be technical and commercial, but for success it must also be a human matter. In that connection he felt that Mr. Sylvester's address had given a good deal of hope to many gas engineers who until recently had not felt certain where they stood.

There followed a meeting of the contributors to the Benevolent Fund of the Institution (see p. 712), and on resumption of the Institution meeting, Mr. D. G. Rose, Coke Manager, North Thames Gas Board, presented a paper entitled 'A Background to Some Economic Problems in the Gas Industry.' This, together with our report of the ensuing discussion, which brought Tuesday morning's session to a close, will be found on later pages. During the interval the President's Luncheon was held at the Savoy Hotel. Our report of the speeches follows this epitome of the proceedings.

On resumption on the Tuesday afternoon there was a new feature—presentation of a symposium of short papers. These contributions will be found on later pages.

Closing Stages

This brought us to the closing stages of the meeting, when Mr. J. Hunter Rioch proposed a vote of thanks to all those who had contributed to the success of the meeting, and in particular to the representatives from overseas, the Institution of Civil Engineers, the authors of papers, the scrutineers of the ballots, the Officers, Auditors, Council and committees of the Institution, and the Secretary and staff of the Institution. Mr. Rioch remarked that it had been his privilege to be a member of the Council of the Institution for three years, and during that time he had gained an inside knowledge of the exacting duties performed so effectively and painstakingly by the Officers, Auditors, Council, and committees of the Institution.

The President, in his address, had referred to the high quality of the work of the Secretary and his staff, but for whom the work of the Institution could not be done so smoothly. No tribute which he (Mr. Rioch) could pay would completely express the deep gratitude of the members for all that had been done on their behalf by the Secretary, but perhaps Dr. Braunholtz would feel a considerable measure of satisfaction in the undoubted success of the arrangements for the present meeting.

Mr. H. D. Greenwood, who seconded, said that having for several years attended the meetings of the Institution as an overseas representative from Europe, he was particularly happy to be given the privilege of expressing on behalf of the members their delight that so many overseas visitors had been able to join them, thereby once again demonstrating the very close ties between members of the gas engineering profession throughout the world. The President, in his address, had recalled that through the wise policy of the present and former Councils of the Institution, in limiting its functions to those proper to a strictly professional body, it could now look forward to a future of perhaps even greater activity as the forum of free discussion on technical and associated problems.

Dr. Braunholtz, in reply, said he was grateful for the opportunity, on behalf of himself and the staff of the Institution, to say a word of thanks to the proposer and seconder of the vote, and to the members for their acceptance of it.

Thanks to Mr. Crowther

Mr. C. H. Chester remarked that it was at this, the last, stage of the annual general meeting that the opportunity was taken to thank the President for his work, for the able way in which he had occupied the chair, for his untiring devotion to the service of the Institution, and particularly for the courage with which he had presented on many occasions the case of the Institution in other spheres. The members owed him a deep debt of gratitude, and were greatly honoured that he had taken this duty upon himself. He had the greatest pleasure in presenting to Mr. Crowther the Presidential Certificate as a mark of the admiration and affection of the members.

Mr. Ben Morgan, Editor, Institution of Gas Engineers, to whose efforts the timely publication of the papers to the Institution Meeting and to that of the International Gas Union was largely due.

Mr. D. D. Melvin, who seconded the vote of thanks, said that on such an occasion one was tempted to eulogise, but in the present instance that was unnecessary, as Mr. Crowther's conduct of the affairs of the Institution had (to use an Americanism) set a new high and spoke for itself. As one of the representatives of the District Associations, he would like in particular to pay tribute to the President for his visits and stimulating addresses to all bodies, both senior and junior. The President had maintained close liaison between the Institution and the Districts, and his visits had given a great deal of pleasure and had stimulated the thoughts of all gas engineers throughout the country. His leadership had been of great value in what had been a year of change. At times he might have been inclined to feel somewhat weary in well-doing, but his achievements in the occupancy of at least three major positions had been thoroughly appreciated.

Mr. Crowther, in reply, expressed his thanks for the generous expressions which had been used and for the manner in which they had been received. He felt that he had done far less than he had hoped to do on taking up his duties, and most certainly he had gained from his office far more than he had given. He was shortly to transfer those duties to his very good friend Harry Chester. '. . I know,' the President said, 'that you will be very safe in his hands, and he has my best wishes for health, success, and pleasure in the post.'

WORLD'S BEST TRAINED GAS ENGINEERS

AMERICAN PRESIDENT'S TRIBUTE TO THE INSTITUTION

THE President's Luncheon was held at the Savoy Hotel on June 14, the principal guest being Sir John Russell, O.B.E., F.R.S., President of the British Association for the Advancement of Science. The Chairman and Deputy Chairman of the Gas Council and ten of the 12 area Boards Chairmen were also present.

The President (Mr. E. Crowther), proposing the toast of 'The Guests,' first extended a cordial welcome to the visitors from overseas. In view of the International Gas Conference which was to open on the following day he welcomed Colonel C. M. Croft, President of the International Gas Union, as the principal international guest. He also greeted the representatives of the gas associations of America, Western Europe, the Dominions and the Colonies and assured them that the Institution cordially appreciated the compliment which their presence paid to them. He felt especially honoured by the presence of Mr. R. W. Hendee, President of the American Gas Association. It was not often that they had been able to attract so important a representative of that Association to their meetings, and they felt it a very high compliment that he had come and presented a paper of so much merit and interest and that he had also consented to propose one of the toasts at the luncheon.

(a) Left to right: Sir Ben Lockspeiser, Mr. A. E. Sylvester, Sir John Russell, the President, Mr. R. W. Hendee, Mr. C. H. Chester, and Lord Falmouth.

Anxieties Ended by Nationalisation?

They were honoured by the presence of representatives of the Governments of the Dominions and the Colonies, and last but not least those of our own British Government. One of the senior representatives of the Government had been heard to remark that his anxieties were over now that the gas industry had been nationalised. Was not that nice, and what were they going to do about it? Next he referred to the compliment paid to the Institution and to him personally by the presence of the Chairman and Deputy Chairman of the Gas Council, and practically all his colleagues on that body. He thanked them individually for their support; it was very pleasant to feel that he and the Institution had their support and sympathy in the work they were trying to do. Great pleasure had been given to him by the fact that in their company were two gentlemen who were Directors of the Company which until recently he had the privilege of serving, each of whom had occupied the chair of the Newcastle-upon-Tyne and Gateshead Gas Company. He appreciated more than he could say all the facilities and kindnesses which they had rendered to him during his spell of office in Newcastle and the opportunity they so readily granted him of occupying the Presidential chair of the Institution of Gas Engineers.

Referring to the principal guest, Mr. Crowther said he had approached Sir John Russell with no little diffidence because he was approaching the culmination of an arduous year of office as President of the British Association, a year which would terminate with the annual meeting in Newcastle. Sir John was one of those to whom the world owed a great debt of gratitude because of his efforts in the interests of increased food production, and they were honoured by his presence.

Sir **John Russell,** responding to the toast, said the members of the Institution were engaged in a most important piece of work, the development of an old industry, an industry which started in this country and which had been developed to a high pitch of perfection within living memory. He remembered the old fish-tail burner which was in use in the home when he was a child, a burner which produced a light with an outer rim of whiteness and a dark centre which was given the name of lambent blue, though it was useless. He recalled that the fitting was one of those which could be raised and lowered, and his father had to pull it down to get sufficient light to read in the evening. He remembered, too, the early gas stoves which smelt, and leaked, and cooked badly, and he thought of the pitch of perfection to which they had now been brought.

The members of the Institution had close links with agriculture, for it was gas chemists and gas engineers who first supplied agriculture with what was to become one of the most important aids to food production—sulphate of ammonia. It was at Rothamsted many years ago that the use of sulphate of ammonia in agriculture was first demonstrated, and although early scientists declared that it was quite unnecessary it became in time one of the most important fertilisers in the world; indeed, it was because of the efficacy of sulphate of ammonia and nitrate of soda that Sir William Crookes was led, in his well known address, to make a forecast which led to the development of the artificial fertiliser industry.

Famous Names Recalled

The first samples of sulphate of ammonia consisted of bluish, sticky, smelly, corrosive stuff which the farmers hated because it damaged their clothes and burned their fingers, but throughout the first world war it provided one of the great agents that saved us from hunger and helped us to defeat the submarine. During that war and afterwards we were largely dependent on the sulphate of ammonia turned out by gasworks, and looking through some documents which Dr. Braunholtz had sent him he came across some familiar names still remembered and honoured in agricultural circles, particularly those of Dr. Charles Carpenter and Sir David Milne-Watson, whose son he was pleased to see on the present occasion.

He reminded those who were doing their bit towards food production as well as gas production that sulphate of ammonia was one of the great necessities of the present time. The world need of combined nitrogen was somewhere about 2¼ mill. tons, reckoned as nitrogen. The world's productive capacity was less than 2¼ mill. tons, so that there was a considerable deficit to be made up. That deficit was a contributory factor in the shortage of food, including the rice crop in Asia, on which a large part of the world depended. If they could get more nitrogen fertilisers the rice output would be increased, and the increase would be an important factor in the pacification of Asia. There was nothing so bad as hunger for causing trouble and discontent. It might not only be in the matter of combined nitrogen that the gas industry could help. Looking through the report of the Institution's committee which dealt with liquors and effluents he could not help wondering whether some of those things which were a nuisance to them might not be of value

(b) Left to right: Mr. R. Lishman, M. Marcel Brabant, Sir Griffith Williams, Col. H. C. Smith, Sir Harold Brown, Sir Alfred Egerton, and Mr. R. Kelf-Cohen.

to agriculture. One had only to think of some of the new and extremely odd things which had come into use in agriculture to realise how very valuable they might be.

Power Problems

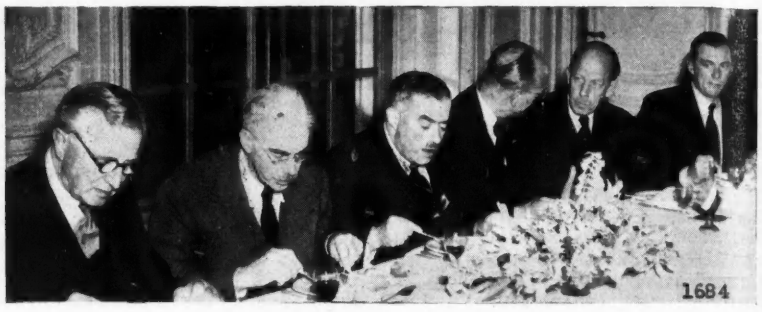
In the matter of power and heat the gas engineer did not at first sight appear to have much to do with agriculture; nevertheless, there was going to be an important power problem on our farms in the not very remote future. We had before the war about 60,000 tractors in use; now we had 260,000, and the number was still growing. Where was the power to come from to keep them going? The French were studying the possibilities of fermenting straw on the farm and converting the product to methane and using it for power purposes on the farm. He imagined the competent gas engineer might devise some form of apparatus in which such a process would be practicable, if it became desirable. The problem of power threatened to become as vital as the problem of food. It had been stated recently that the power used in this country, expressed in calories, was not less than 50 times the calories consumed by all the human beings in the country. From the thermodynamic point of view the efficiency of utilisation was only about 3 or 4%. We did not live in a perfect thermodynamic world; there was a considerable loss of efficiency in our present use of power.

The Institution of Gas Engineers was fortunate in having good scientific staffs, and good research work going on. He had been impressed with one of the closing paragraphs of Mr. Crowther's Presidential Address in which he pointed out that many of the discoveries of recent years were based on research work done long ago—done, but not recognised, and that the need to-day was for interpreters of that research. Sir Richard Southwell had said recently that the engineering of to-day was based on lessons of 50 years ago, and the same was true of many other industries. One of the great problems of organisations such as the Institution of Gas Engineers was to close the gap between the research laboratory and the practical application of research so that the discoveries of today might be used, if not to-day, at least to-morrow, and not in 50 years' time. In that great task they had the good wishes of all who had the interests of the country at heart.

Greetings from the United States

Mr. **R. W. Hendee,** President of the American Gas Association, proposed the toast of 'The Institution of Gas Engineers' and said that for many years the gas industry of the United States had regarded the Institution with deep respect and admiration. It was in the enviable position of having received official recognition in the public service of the country and it was an undoubted fact that they had developed the most expert and thoroughly trained gas engineers in the world. The Institution's unvarying high standard of qualifications for membership, its achievements at comparatively low cost in the field of practical research, and last but not least the splendid character of its leadership combined to earn and retain the admiring interest of the American people. For years the American Gas Association had, with great pleasure, accorded Honorary Membership to the President of the Institution, and the friendliest relations and co-operation between their two organisations had always been maintained. Except during the war years the American Gas Association had usually been represented at the meetings of the Institution, and they had the honour and pleasure of entertaining a number of members in Chicago and other cities on the occasion of the visit of the Institution to the United States in 1934; in fact, the two organisations were a true example of voluntary international co-operation.

Possibly, though not probably, someday someone would write the story of how the gas industries of their two great countries kept the public demand supplied under conditions of enemy attack and shortages of material and labour. But they were all now more interested in their problems of to-day and to-morrow, and with those problems in mind he had the honour of proposing the toast of the Institution.



(c) Left to right: Sir Alfred Egerton, Mr. R. Kelf-Cohen, Mr. A. M. F. van Mierlo, Mr. F. W. Foot, and Mr. G. M. Nave.

(d) Left to right: Miss K. M. Halpin, Sir William Larke, Sir Harry Lindsay, Col. C. M. Croft, and Mr. J. D. Cowen.

Education and Research

Mr. **C. H. Chester,** O.B.E., M.I.MECH.E., M.INST.GAS E., President-Elect of the Institution, replying to the toast, acknowledged the able and interesting paper which Mr. Hendee had presented to the Institution on the subject of peak load problems, problems which gas engineers in this country and the members of the International Gas Union whose conference was about to open were now beginning to appreciate more fully. Mr. Hendee had had a meteoric rise in the gas industry of America and he also found time to fulfil a multitude of civic duties and social duties. Among his many other activities Mr. Hendee was proud to belong to a famous golf club at Broadmoor, a name which, he warned him, had less distinction in this country. As President of the American Gas Association as well as of his own Company, Mr. Hendee recognised the necessity for technicians to develop their plants and he had pointed in his paper to the necessity for the technician in the layout of gas administration. After hearing the able address of Mr. Sylvester that morning they felt reassured that the Institution would play an even more important part in the development and the

(*Continued on p. 739*)

(e) Left to right: Mr. E. J. Tucker, Prof. D. M. Newitt, Sir Charles Ellis, and Mr. C. W. Pilo.

NEW I.G.E. PRESIDENT AND VICE-PRESIDENTS

C. H. CHESTER, O.B.E., President of the Institution, 1949-50.

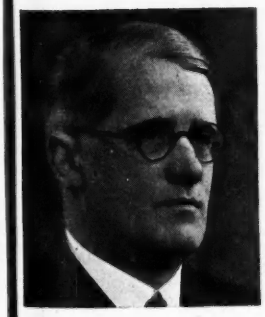
F. M. BIRKS, C.B.E., Senior Vice-President.

J. H. DYDE, M.SC., Junior Vice-President.

THE 1948 INSTITUTION MEDALLISTS

A fundamental appreciation of the present technique of distribution in this country and a farsighted approach to future problems characterised the paper by Mr. **H. J. Escreet,** B.SC. (ENG.), entitled 'A Survey of Gas Distribution Practice.' This paper, which was presented at the 85th annual general meeting of the Institution of Gas Engineers last June, was chosen for the Institution Gold Medal, 1948. Mr. Escreet, who has had a wide experience in distribution practice, first as Distribution Engineer of the former Gas Light and Coke Company, and now as Distributing Engineer of the North Thames Gas Board, divided his subject into two parts. The first gave a review of current distribution practice; the second was concerned with the design of distribution systems to supply gas for 'whole house heating,' as well as for cooking, water heating, and refrigeration. The survey clearly revealed the importance of annual consumption per domestic consumer upon present-day costs of mains and services, and served to show the problem which may arise when the economies of supply to new satellite towns have to be considered.

H. J. ESCREET.



T. C. FINLAYSON.

The H.E. Jones London Medal, 1948, was awarded to two officials of the Woodall-Duckham Company, Mr. **T. C. Finlayson,** M.SC., Technical Director, and Mr. **F. S. Townend,** B.SC.(ENG.), Senior Assistant, Design Department. Their joint paper on 'Gas Production in Perspective,' was presented at the 85th annual general meeting of the Institution of Gas Engineers in London last year. The paper, which provided a concise summary of the framework within which the gas industry has developed in Great Britain, dealt with the significant features connected with current practice of gas manufacture. The future possibilities of gas production also received considerable attention in three sections covering the coke/gas ratio, new processes, and the purchase of coke oven gas, with particular emphasis on the two allied problems of flexibility of output and the gas/coke ratio.

F. S. TOWNEND.

Mr. **J. A. Tomes,** Deputy Engineer and Manager of the Stourbridge undertaking, was awarded the Institution Silver Medal, 1948, for his paper on 'The Application and Potentialities of Town Gas in the Hand Blown Domestic Glass Industry.' The paper was read at the Autumn Meeting of the Midland Association of Gas Engineers and Managers.

J. A. TOMES.

J. A. WILLIAMS.

The winner of the Institution Bronze Medal, 1948, was Mr. **J. A. Williams;** his paper, 'Laying a Gas Main in the Sea,' was presented at a general meeting of the London and Southern Junior Gas Association, on April 16, 1948. Formerly of the Gas Light and Coke Company, Mr. Williams is now Development Engineer of Laporte Chemicals, Ltd., chemical manufacturers.

THE INSTITUTION'S PLACE IN THE NEW ORDER

MR. E. CROWTHER'S PRESIDENTIAL ADDRESS*

THE past year has seen the close of one epoch and the opening of another in the history of the gas industry. With so many of our members personally affected in their positions and prospects by the change to public ownership, and with strong and diverse views entertained by many, I have been greatly impressed by the failure of controversy to impair the strength and unity of this Institution. The change is now complete, the dust of controversy has settled, and arguments for or against the public ownership of the industry have ceased to be of more than academic interest. Sufficient to say that the personal credit of each one of us now engaged in the supply of gas to the public is fully involved in the success of the industry in its new shape. Practising democracy as we do, and not merely paying lip service to it, the future of the industry could rest on no more secure basis.

The message of the Minister of Fuel and Power to the Institution leaves no doubt as to the reliance which he places upon each individual member in the work ahead. In the Minister's own words—

> 'It (nationalisation) does little more than create an opportunity—which it is for those in the industry to grasp. The aim must now be to raise the standard of the whole industry to that of the best of the existing undertakings. To the achievement of this aim every member of the Institution will, I have no doubt, give of his best in the interests of the industry and the nation.'

Apart from individual considerations, the minds of many have been exercised as to the place of the Institution itself in the new order, and the nature of its future contributions to the well-being of the industry.

Unaltered by Nationalisation

In this regard, it is noteworthy that of all the national organisations of the industry, the Institution is the only one to remain unaltered in its constitution and personnel by nationalisation. In the past, by avoiding any excursions into territories foreign to its constitution and Charter, it has remained strictly a professional and technical body. To ensure this, it took the initiative in earlier years, when it was virtually the sole link between undertakings, of promoting the creation of separate and distinct bodies to attend to matters outside its true province—matters, for example, concerning labour relations, publicity, sales promotion, and legal and Parliamentary affairs—when these began to preoccupy many of its members. These bodies, in a sense the children of the Institution, having well served their day and generation, have now ceased to be, and their heir is the Gas Council, which, to extend the metaphor, the Institution may claim as a grandchild. The wisdom of its policy of limiting its activities to matters proper to a professional body has become abundantly clear as an essential condition for its continuance as a vital influence in the conduct of the industry.

It is my conviction that the services of the Institution as a forum for technical discussion, as a medium of consultation and contact, and as the guardian of professional standing and integrity will be of even greater significance to its members in the future than in the past, while as a prophylactic against the insidious diseases of bureaucracy it will prove priceless to the industry.

With these considerations in mind, it has been the aim of the Council throughout the year to make the Institution an increasingly vital factor in the professional life of its members. To this end, among other steps, the *Bulletin* has been launched, and may prove the forerunner of a journal in which matters of technical and scientific interest will be published. The new headquarters' building, preparation of which is proceeding well, supported by subscriptions totalling more than the anticipated sum, will contain in addition to committee rooms, library, and offices, a room in which members may meet in a club atmosphere, with the same purpose in view.

By continuing and enlarging its work in educational fields and upon the many technical subjects which it has made peculiarly its own, in all of which it has access to the help of distinguished specialists from without the industry, difficult if not impossible to secure except through the medium of a Chartered body, the Institution can offer to the Gas Council the use of an efficient and proved machine. Were this machine not in being and at work, its necessary creation would occupy an unpredictable length of time. Among the technical matters with which the Institution and its Committees are concerned are the design and testing of meters, the disposal of effluents, gas quality and combustion characteristics, and the safe operation of plant. All are subjects of special interest to the Gas Council, and the accumulated information upon them available to the Council through the Institution will be of great value.

The work of the Institution Committees is performed with particular enthusiasm and energy because it is entirely voluntary, and an invitation to serve upon a Committee is regarded as an honour. The preservation of this wholly desirable outlook will, in my view, best be ensured if the present system is continued, and as much as possible of the work retained in the hands of the Institution as an advisory body to the Gas Council.

The rôle of the District Associations, now that they have relinquished to the area Boards their less technical functions, must closely correspond with that of the Institution. For this reason, the case for their reconstitution as district sections of the Institution seems very strong, and I have observed with satisfaction a progressive growth of opinion in this sense on the part of their members, with the prospect of early and effective action by more than one of the Associations.

Steadily increasing demands for gas, in both domestic and industrial spheres, at a time when plant construction has been and continues to be limited in amount, slow in execution, and above all extremely costly, have been and remain a major preoccupation. As growing capital expenditure both on works and district makes its effect increasingly felt, it may be that consequent increases in gas prices will slow down the rate of expansion of our business. On the other hand, improved standards of comfort and convenience demanded by all sections of the public and made practicable by the development of the housing programme will continue to encourage increased domestic sales.

In industry, only the competition of oil, of which world prices have tended latterly to recede, is likely to be a major restraining factor upon the demand for gas, at least so long as present levels of employment can be maintained. Coal has ceased to be an acceptable fuel in many industrial applications.

District Heating

The publicity given to 'district heating' systems, burning coal, is likely to diminish as experience proves that the estimates commonly quoted for their cost are gravely over-optimistic, although the danger remains that certain local authorities, anxious to embark on new activities in replacement of those which have passed out of their hands, may introduce district heating without regard to its true economics. Where this occurs, and their tenants are given no choice but to accept the system, gas will be barred from competition in certain fields appropriate to it, and consumption in such areas will be lower than in a freely competitive market.

Possibly the most potent influence towards further expansion of our business will prove to be the development, as integration proceeds, of major-undertaking standards of technique, efficiency,

Communication No. 349 of the Institution of Gas Engineers, presented in London June 13, 1949

and service to areas hitherto less efficiently supplied. In attempting to assess future prospects, it is interesting to recall the views expressed less than five years ago in the Heyworth Report, to the effect that a 20% expansion of sales might be expected in the 10 years following its preparation. In fact, during the first four years of this period, an expansion of 22½% has already been recorded.

Without attempting a forward estimate of my own, it seems clear to me that it is imperative to create some modest margin of plant capacity, where it does not now exist, beyond immediate requirements, although for reasons which I propose to develop I consider it equally essential to exercise great caution under present conditions in determining both the amount and nature of any new construction. In so doing, it is necessary to bear in mind that to the extent to which it is concerned with space heating and with 'whole house' heating in particular—business which we cannot afford to shirk—expansion will increase seasonal peak loads, with their associated problems both of manufacture and distribution.

An Urgent Requirement

An intensified study of seasonal peak loads, which have assumed an importance to the gas industry comparable with that of the momentary peak load to the electricity industry, and which holder capacity does little or nothing to ease, appears to me to be an urgent requirement.

Returning to the subject of new construction, it may be calculated that at present capital cost levels new carbonising plant with its associated coal and coke handling equipment, if in continuous operation on base load, requires a charge of some 7s. per ton of coal carbonised to meet interest and redemption charges, assessed on the most favourable basis. This charge per ton rises, of course, in proportion as such plant is employed to a less extent than upon 365 days per year: should new carbonising plant be used only to supply seasonal peak load, the influence of capital cost upon this peak-load gas becomes extremely great. It is no less necessary to recognise that similar consequences arise if the use of such new plant upon base-load production causes existing similar plant of comparable efficiency to be relegated from base- to peak-load production.

It follows that where sufficient plant already exists to satisfy all demands, it is preferable financially to continue to accept a considerable degree of ineconomy, if this is inherent in the existing plant, rather than to replace it by new. The measure of the tolerable ineconomy up to a daily gas output capacity of perhaps 60% of the maximum day is the figure already quoted of 7s. per ton upon the tonnage of coal which the plant can carbonise, while to replace the whole of the plant would involve a charge for capital service of the order of 10s. per ton of coal actually carbonised. Such figures as these allow a very wide latitude of ineconomy before the scrapping of old plant and its replacement by new can be justified upon strictly financial considerations.

Where the question is one of meeting additional demand rather than of replacing uneconomical plant, load factor becomes the main consideration in examining capital costs. Assuming, for example, that it is desired to enlarge efficient carbonising plant to permit of a 25% increase in both annual and maximum day's output of a station which is the sole source of supply to a typical district, the equivalent load factor upon the additional plant will be not more than 25%, since for at least eight months of the year the original plant could carry the whole of the load even after the development of the new business had been effected. Admittedly, this implies an improved load factor upon the original plant, but concurrently the cost of the new plant, if regarded as falling wholly upon the gas which it is beyond the capacity of the original plant to provide, is of the order of 2s. per 1,000 cu.ft. of such gas.

While the load factor in such circumstances might be lifted by employing gas instead of coke to heat a proportion of the settings during the light-load period of the year, and the economics of such a practice will repay study, its possible consequences upon the coke market, if widely employed, are difficult to estimate, and one is inclined rather to seek gas-making plant of lower capital cost, if higher in operating cost, to carry additional load during the seasonal peak period. Carburetted water gas plant, for example, although unable to compete in cost with carbonising plant for base-load production at present price levels of coal, oil and residuals, becomes the cheaper source of production, inclusive of capital charges, at any load factor below 50%, its advantage increasing progressively as the load factor falls further.

Working and Capital Costs

The essential disability of carbonising plant lies in the fact that it converts only about one-quarter of the therms supplied to it as raw material into the desired gaseous product, leaving the major part of the original therms still in a solid form not greatly different in market value from that of the raw material. As a consequence, working and capital costs incurred in treating four therms as coal must be charged mainly against one gaseous therm.

There may be several lines of attack upon this situation :—

(1) Carbonisation may be modified so as to deliver the solid therms in a form saleable at an appreciably higher price than that commanded by the original coal, with the object of keeping the plant at work profitably throughout the year. Such a system is illustrated by two existing—and widely different—carbonising processes, namely, low temperature carbonisation designed to produce an acceptable solid smokeless fuel for domestic use, and coke oven carbonisation producing a hard coke essential to the metallurgical industries. There is, indeed, already a trend towards the adoption of coke ovens in large-scale gas undertakings, and this trend may be expected to develop as integration proceeds.

(2) New types of carbonising plant may be devised, capable of being constructed much more cheaply than those with which we are familiar and having lower working costs per gaseous therm produced. Recent developments in the production of heat and stress resisting metals in connection with the gas turbine suggest that we may not always be limited to silica and fireclay as the materials for retort walls, while new and more precise methods of applying heat to coal are not beyond imagining.

(3) Extremely cheap total-gasification plants may be devised to stretch the production of existing carbonising plant at times of peak demand. On low load factors, such plant would be

Informalities

The photographs on this and the six pages following constitute a permanent record by our Staff Photographer of friendly encounters and casual conversations which, it is hoped, will evoke pleasant memories in the future.

We realise that many readers will be anxious to possess prints of some of these photographs as a reminder of a successful meeting. Accordingly, arrangements have been made to supply prints of all the photographs in this issue which bear a serial number Applications, quoting the numbers required, should be sent to Walter King, Ltd. (Photo Department), 11, Bolt Court, Fleet Street, E.C.4. The price of prints is 3s. full plate, 2s. 6d. half plate, and 4s. 6d. 10 in. x 8 in., including postage.

relatively economical even if low in thermal efficiency, permitting the use of a proportion of oil for enrichment purposes, notwithstanding that the cost of a therm of oil is more than double that of a therm of coal. The use of producer gas on the one hand (largely practised at Liverpool), and of oil-gasifying plants on the other (as recently developed by the then Gas Light and Coke Company) are examples of the financially advantageous use of plants of low capital cost. It is not impossible that the merits of these two examples may be combined in some new type of plant, and their disadvantages—the low calorific value of the one, and the thermal inefficiency of the other—minimised.

In carbonisation at least, the inescapable fact which we must keep always in mind is that our principal raw material, coal, costs less than 3d. per therm. This must be the figure to which we should seek as nearly as possible to approximate in the cost of the gaseous therms which we produce.

Economics of Gas Making

I have discussed this topic at some length in order to draw attention to the need for a review of established ideas upon the economics of gas making, a need sharply emphasised by the severe rise in the capital cost of plant at a time of expanding load. The immediate construction of additional plant of standard type—particularly of carbonising plant—without the closest consideration may lead to acute financial difficulty, which will be aggravated should the ratio of coal price to residuals prices increase, as appears not unlikely. A stop-gap policy for a few years, even at the sacrifice of taxation relief upon new capital expenditure, may well prove to be advantageous in the long view, judging from the trend of prices in the years which followed 1918. In the meantime, much might be gained from a searching examination of the research work of recent years, and an enquiry as to how far it contains answers to some of our problems.

The gap between the scientist and the engineer is too wide : it is not so much that the gas industry's immediate need is for more research as that it needs a liaison staff to appreciate the implications of the work already done, and to explain and clarify these to the plant designer and operating engineer.

A great deal of work has been done, for example, during the life of the Gas Research Board upon many aspects of combustion and the behaviour of a variety of combustible gases and combinations of gases. In spite of this work, it has been left to the engineer to discover for himself, as a result of expedients forced upon him by exceptional conditions and shortages, that strict consistency of calorific value, composition, and specific gravity are not necessarily essential to satisfactory burner performance. Not only has he learned that burners of normal types are more tolerant of an appreciable variation in any one of these properties of town gas than had been supposed, but, more important still, he has found that an enforced variation in one property may be compensated by a deliberate variation in another. Thus the rigid standards at one time regarded as the chief criteria of good practice have lost much of their significance, and it has been found possible to meet peak demands and unusual situations of many kinds by the use of unconventional plants and methods without which serious shortages of gas supply might have occurred.

It is disconcerting to realise that these 'discoveries' are, in fact, implicit in the research work to which I have referred. It is the lack of an interpreter of the knowledge, not the lack of the knowledge itself, which has caused the engineer to reach a conclusion by trial and error which, when reached, and not before, he is able to recognise as a logical deduction from the work of the scientist. There is no suggestion that either the scientist or the engineer is to be blamed for such a situation : it is as difficult for the former to appreciate the practical problems of the latter as it is for the latter to recognise the direction and significance of the scientist's reports. If, however, each is to make his fullest contribution to technical progress, some closer liaison must be effected between them, mitigating the consequences of over-specialisation—the modern equivalent of the curse of Babel—which afflicts the world of science and technology.

As a suitable 'exercise,' a combined attack might usefully be made upon the apparent dilemma of the most favourable calorific value. Here considerations of manufacturing cost in conditions of growing demand appear to suggest a lowering of calorific value, permitting an increased use of water gas with progressive carburetting as the seasonal peak develops. Simultaneously, considerations of distribution cost appear to point in precisely the opposite direction, as higher calorific values with lower specific gravities would increase the effective capacity of over-loaded mains services and meters. Is it possible that the answer to the dilemma is latent in work already in hand in our laboratories ?

These speculations point to the need for the widest possible outlook on the part of those who direct the industry, so that the various abilities of all those engaged in its service may be employed at the highest efficiency. The Institution has sought to promote such an outlook on the technical side of the industry, and in its educational work to inculcate in those who aspire to corporate membership a knowledge of the underlying scientific principles of mechanical, civil and chemical engineering, as well as an actual proficiency in those arts themselves.

In so doing it has placed no light task upon young men called upon to attend to full-time specific duties in junior posts as well as to undertake an arduous and prolonged course of study. The achievements of so many of these men reflect great credit upon their tenacity and ability.

With the developments in the activities of the industry for which we look in the future, we may expect to see corresponding developments in our educational system and in the facilities available to our technical recruits, leading naturally to a widening field of recruitment. The time is opportune to introduce a proportion of technicians of varied experience into the industry : architects to plan our new structures, civil engineers to develop distribution networks, electrical engineers to control power generation and usage at our works, and chemical engineers to devise new and improve existing processes. There will be increasing scope for all of these, and the first to welcome such men of ability to the gas engineering profession will be those who have made it their life work, serving the industry well and faithfully.

PEAK-LOAD PROBLEMS IN THE UNITED STATES*

By R. W. HENDEE, PRESIDENT, AMERICAN GAS ASSOCIATION

BECAUSE of the wide geographical separation and diversity of operating conditions among local gas companies in the United States, our peak-load problems are characterised by an unusual degree of complexity. Until recently there was a sharp line of demarcation between natural gas and manufactured gas, but the development of long-distance trunk-line transmission on a large scale, bringing natural gas into manufactured-gas territories, is focussing attention on broad areas of common interest.

The present tendency is for natural gas, when it is brought into manufactured-gas territory, to augment and supplement the manufactured-gas supply. Instead of all manufactured-gas facilities being abandoned, as was formerly done when natural gas was introduced, they are being revamped so as to secure the most economical results from use of the two gases. Instead of straight changeovers to natural gas, natural gas is being used as a basic component of manufactured or mixed gas.

Experience has demonstrated that the introduction of natural gas into most manufactured-gas areas, far from solving the peak-load problem, has served to intensify it. This is because natural gas is a relatively cheap fuel, even at the end of long transmission lines, and tends to increase further the competitive advantages of gas over other available fuels for space heating. The public demand continues to outrun the supply in most areas. Moreover, since econonomic trunk-line transmission of gas demands a very high load factor, the larger peaks, due to greater space heating demand, must be met by still further augmenting the existing facilities for producing manufactured and mixed gases.

The variety of permutations employed to utilise natural gas in conjunction with manufactured and liquefied petroleum gases to meet peak-load conditions gives the current literature on this subject an appearance of bewildering complexity. The basic principles, however, are relatively simple. The sendout gases of the various distributing systems comprise one or more of the following components:—

(1) High B.Th.U. gases.
   (*a*) Natural gas. (*b*) High B.Th.U. oil gas (including refinery oil gas). (*c*) Liquefied petroleum gases.
(2) Intermediate B.Th.U. gases.
   (*a*) Coal gas. (*b*) Oven or retort gas. (*c*) Carburetted water gas.
(3) Low B.Th.U. gases.
   (*a*) Blue gas or water gas. (*b*) Producer gas.

The direct transition from any member of Group (1) to 3(*a*) is possible by re-forming or reacting with steam. This may be accomplished either by the older cyclic method of passing the hydrocarbon vapours and steam through the fuel bed of a water gas generator or by the more recent continuous method which employs a heated catalyst to effect the conversion. It is also possible theoretically to go from a lower B.Th.U. to a higher B.Th.U. group by converting carbon monoxide and hydrogen to methane, a process started in Germany and now under consideration, but not as yet in commercial use, in the United States. It is obvious that the possible permutations of these basic gas components will permit a wide choice of sendout gases at any desired intermediate B.Th.U. level. In practice, these choices will be determined by local conditions with respect to cost and availability of raw materials and the interchangeability limits of the gas mixtures.

One of our large Midwestern cities presents a typical illustration of the changes which have occurred in the peak-load situation in the last two decades. In 1927, the ratio of the maximum to the minimum daily sendout was about 2 : 1. In 1947, this ratio had increased to 3 : 1, and, in addition, the maximum sendout had increased threefold. A company may possess sufficient capacity to satisfy maximum demands, but it obviously cannot satisfy them profitably if the variations exceed certain limits. These limits of profitable operation depend on the nature of the equipment and processes used rather than upon the capacities. Thus, in general, the gas utilities are faced not only with the necessity of greatly expanding their average gas-making capacities, but of handling an increasing spread between maximum and minimum sendouts, both daily and seasonal, and of doing so without prohibitive increases in capital investment.

Solution of the Peak-Load Problem

The peak-load problem has been growing in intensity and will likely continue to do so. Fundamentally, its solution is a matter of economics, which involves rates. We are in pursuit of further knowledge as to the basic economic factors involved, and, having acquired it, are confident that we shall find the solution to our problem. Our prime job, however, is to render service principally through the medium of the gas which we distribute.

Solution of the peak-load problem falls generally into the following six categories, one or more of which may prevail for any given situation:—

(1) Adaptation of Existing Plants.

The first approach to a peak-load problem is to study every possible means of increasing the capacity and adaptability of the present plant. From the process standpoint it is necessary to emphasise greater adaptability to intermittent operation by simpli-

* Communication No. 350 of the Institution of Gas Engineers, presented in London on June 13, 1949.

fying operations, reducing personnel and holding down investment requirements and costs. If new equipment is required it can be engineered for most efficient continuous use, even though requiring high investment. Existing equipment can be used for stand-by or peak purposes. Under the necessity of war our engineers made an extended and careful analysis of their plants, and, by the application of wartime measures, the discarding of some previously held conservative beliefs and an interchange of ideas, they were able to increase greatly their gas-making capacities. In some cases plant capacity was raised as much as 35%.

Expanding the gas-producing capacities of existing equipment by separation of the water gas and oil gas functions and the elimination of purely mechanical bottlenecks is a new idea which represents an important trend in the thinking of American gas engineers. Analysis of the two separate gas-making operations conducted in a standard water gas set—namely, water gas from coal or coke and enrichment gas from oil—has led to the conclusion that the capacities of the generator and the carburettor-superheater units, respectively, can be substantially increased if these operations are not tied together and operated simultaneously. Each process constitutes a bottleneck limiting the maximum output of the other. The superheater can be heated more rapidly if not tied to the necessities of proper fuel bed temperature control. Control in the generator becomes simpler if the operating cycles are made independent of the need for obtaining proper heat balances in carburettor and superheater. It has been found that the increased capacities made possible by separating these two operations usually reveal other mechanical bottlenecks in connections, take-off mains, blowers and other plant equipment.

There is great technical interest in the developments directed toward process improvements in the separated oil and water gas production units. In the case of the high B.Th.U. oil gas components, the objective has been not only to increase capacities, but also to permit the use of higher carbon content oils. The efficient utilisation of high carbon oils has become increasingly important as a result of the newer catalytic and thermal cracking processes in the petroleum industry, use of which has decreased the availability of low carbon residuum oils.

The most important recent advance in this direction has been the development of the Hall High B.Th.U. process under the sponsorship of the Gas Production Research Committee of the American Gas Association. We have been able to handle oils up to 13% Conradson carbon with fuel savings of the order of 30% increased gas outputs of at least 35%, and savings on new equipment investment approximating 50%. This process lends itself either to existing or to new equipment.

(2) Catalytic Re-forming.

One of our most important process advances has been the continuous catalytic generator for producing water gas by re-forming simple hydrocarbon gases and vapours. The production of hydrogen by catalytic re-forming of natural gas or refinery oil gas has long been practised in the hydrogenation industries where a catalytic water gas shift reactor is added to complete the conversion of carbon monoxide to hydrogen and carbon dioxide, the latter being removed by water scrubbing. Our research programme has emphasised,

(*a*) Production of the maximum possible output of water gas per unit of plant investment.

(*b*) Extension of the range of usable hydrocarbons from the simpler refinery oil gases and natural gas to the higher hydrocarbons such as

(i) propane and butane which can be stored in pressure vessels, and

(ii) gasolines, light naphthas, and gas oils which can be stored at low pressure.

The problems of catalytic carbonisation and regeneration were the chief stumbling blocks in the development of this process, but these have been solved for propane, butane, and gasoline, both paraffinic and olefinic. Gas oils pose a more difficult problem requiring further research.

In general, the use of air or oxygen admixed with the steam has been helpful in reducing catalyst carbonisation, especially in the presence of sulphur. Preheating to incipient cracking has proved essential with the higher paraffins and olefines, and improved control both of catalyst operation and catalyst regeneration temperatures has been an important factor in increasing the throughput capacities per unit of catalyst volume. Thus the production of water gas by continuous catalytic re-forming plus subsequent enrichment to the desired heating value offers the gas industry a highly flexible and important means of meeting a variety of peak-load conditions.

In the first place, the process is highly instrumentated and automatic, thus requiring a minimum of skilled labour. In the second place, there are no by-products of tar or light oils requiring separation and handling. Consequently, relatively small stand-by units can be located at strategic points on the periphery of the distribution system and the products can be fed back into the system, thus minimising distribution bottlenecks.

During off-peak periods, if natural gas is available and is used to produced a manufactured or mixed gas, appropriate B.Th.U. values can easily be obtained by re-forming part of the natural gas and enriching it with the balance. Then, under peak-load conditions, the catalytic units can be shifted to operate on stored propane, butane, or gasoline, using natural gas as a high B.Th.U. component. This levels out the demands upon the natural-gas transmission lines. On the other hand, if natural gas is not available, high B.Th.U. oil gas components can be made by the oil gas generators and the required low B.Th.U. gas components supplied either by re-forming part of the oil gas or by re-forming stored propane or gasoline, the choice depending upon local facilities and available raw materials.

(3) Use of Liquefied Petroleum Gases.

The concentrated heat units in liquefied petroleum gases make it possible to store them at reasonable capital costs. The ease with which they can be gasified makes them adaptable for mixture with other gases. A sizeable total of liquefied petroleum gas storage capacity for meeting peak loads, both on manufactured and natural gas systems, has been installed by the gas utilities in the United States and the amount is increasingly rapidly. The unit cost of these gases rose steeply during the war, but low capital costs offset high gas costs sufficiently to make their use

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economical in many cases, especially where peaks are of short duration and the supply can be restored between peaks.

(4) B.Th.U. Variation.

In certain localities the bottleneck to higher peak loads is the distribution system. In such cases the most immediate solution is to raise the B.Th.U. content of the sendout gas. This approach has been employed at Cambridge, Massachusetts, where the entire system has been converted to oil gas of about 1,000 B.Th.U. Other systems will doubtless be converted in the near future, hastened by development of the Hall High B.Th.U. process.

(5) Underground Storage.

Underground storage at or near the end of long-distance transmission lines has assumed major proportions and is an important factor in meeting peak-load demands for natural gas. Abandoned or partially depleted natural gas fields which are free from leaks and can be controlled by a single party or group are being repressured during off-peak periods and drawn on during peaks. According to latest records, over 200 bill. cu.ft.* of natural gas are now stored underground, largely in our Appalachian region, and this amount will be greatly increased by next winter. In some cases the operation of native local fields in conjunction with long-distance transmission lines produces the same results, the local fields being drawn on only in emergencies or during peak periods.

For the same purpose, but to a lesser degree, underground pipe nests, operating at pressure above 2,000 lb. per sq. in., have been installed to carry a gas supply for short peaks. For limited capacity requirements this type of installation can be made at a lower capital cost than any other fabricated storage device. It is more costly, however, than underground field storage.

In one plant, natural gas was liquefied at low temperature and low pressure and stored to meet peak conditions. The system gave promise of being an economical method of meeting many peak-load problems, but an unfortunate failure due to mechanical troubles has retarded development and expansion.

(6) Load Selection and Control.

The most practical and the cheapest method of meeting peak-load problems, where it can be done, is the selection and control of the load itself. In almost every system, whether serving manufactured, natural, or mixed gas, some loads can generally be found that can be dropped during the peak periods without undue annoyance to the customer, or loads which can be taken on and served economically only during off-peak periods. On large systems, particularly those serving natural gas, interruptible loads are a regular thing. Weighing the competitive features, customer reaction and the cost of stand-by service against the savings in fixed cost of additional gas facilities leads to a rather delicate balance, but today, in the United States, load selectivity and control are everywhere receiving much attention.

Where loads are interrupted, several methods of handling the customers' requirements are in effect. In the majority of cases the customer is expected to furnish his own stand-by in substitute fuels and to operate it at his own expense when the gas company is required to use its capacity during peak periods to serve its base-load customers. In some cases it is possible for the customer to discontinue entirely his operations during such periods. In other cases, where gas is sold at a higher rate, the gas company may provide the stand-by facilities on the customer's premises, pay for their operation and maintenance, and charge the customer for the gas equivalent. Occasionally, in ceramic plants paying higher than a 'dump load' rate, the gas company may reserve the right to discontinue service but give back to the customer sufficient free gas to bring his furnaces and the product in them back to the heats they had when service was discontinued.

Electric power plants and other large boiler loads offer the best balancing loads for natural gas transmission lines, and where the distributing company which purchases natural gas is a combination gas and electric company the power plant offers a double opportunity for saving.

The question has been raised by some persons in high authority as to whether pipeline companies should be allowed to sell natural gas for large uses in competition with other lower-grade fuels or our supplies of natural gas conserved for the primary benefit of residential customers where competition from solid fuels is less remote. Certain regulatory authorities have sought means of controlling the 'end use' of gas. Thus far, however, the economic aspects of such loads in relation to efficient pipeline operation have been controlling.

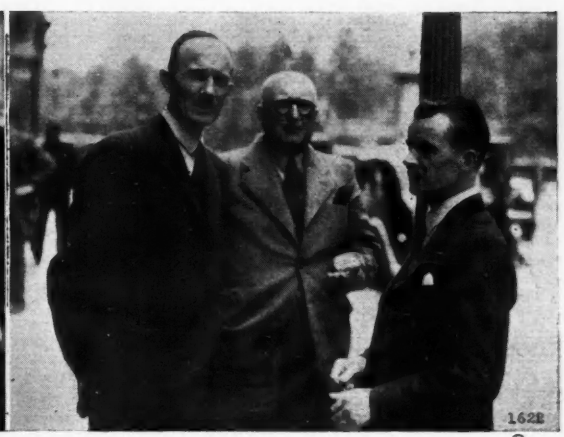
Mixed Gases

The multiplicity of gases available and the pressing need to employ every available gas, not only for peak-load situations, but also for economical base-load operations, has made imperative a more exact knowledge of gas interchangeability relationships. A number of empirical formulæ, such as the 'Knoy' and the A.G.A. 'C' factors, have been developed as a means of estimating the percentage of various substitute gases which can be safely employed with certain base gases without excessive burner troubles from flash-back, lifting or yellow tips. Test-burners have also been devised by various companies as a criterion of gas interchangeability in their own systems. All these have been used with some degree of success for local conditions in which the range of gas variables was not excessive.

The entire subject has been exhaustively reviewed under the A.G.A. research programme. The criterion of interchangeability selected was the behaviour of the gas mixtures with respect to flash-back, lifting, and yellow tips upon a group of 12 commercial appliance burners. These burners were selected experimentally from a survey of the entire field as being the 12 most critical in respect to one or more of the three burner behaviours cited above. An examination of these extensive data confirms the conclusion from earlier field experience as to the inadequacy of any existing formula or test-burner. When the research work is completed, the interchangeability of a large number of supplementary gas mixtures with the important base gases will have been directly determined and reasonable predictions can be made by interpolation with respect to many others. Whether or not these data will lend themselves to a comprehensive mathematical analysis and to the development of universally applicable gas interchangeability equations remains to be determined.

In conclusion, let me point out that the very existence of the

*1 cu.ft. = 0.0283 cu.m. 1 bill. = 1,000,000,000 in the U.S.A.



peak-load problem and the measures being taken to solve it indicate forcibly the fluid, dynamic condition of the gas industry to-day. Loads hitherto considered unattainable are now either coming on to our lines or are being sought. We have come pretty much to the conclusion that wherever heat energy is required there is a use for gas. Our concepts of sales and service have changed materially and our concepts of production, storage, transmission, and distribution—the physical problems—must undergo and are undergoing similar drastic changes. But whatever happens in the next few years will depend upon to-day's efforts to meet these problems. Through research we shall find the answers to many of our problems. Through research we shall bring to-morrow much closer to to-day. The gas industry in every country and industry everywhere will find through research a common bond.

DISCUSSION

The **President** thanked Mr. Hendee for his very stimulating and important paper, which was bound to give rise to one of the keenest discussions which had taken place for many years.

Mr. F. M. Birks, Vice-President (North Thames Gas Board), said it gave him particular pleasure to join in the discussion on the paper because, although he had been a member of the American Gas Association for many years, he had not had an opportunity of meeting a President of that body for a long time. Further, the subject of the paper was one in which he took a great interest, as it was one of such importance that it was impossible to emphasise too highly the great advantage of interchange of ideas and information on as wide a basis as possible.

For many years he had maintained contact with a number of observers in the United States, and had been particularly intrigued by the change of thought there concerning the peak-load problem. Mr. Hendee had shown how the present trend was to utilise natural gas for base-load supplies, so that the transmission lines could be fully employed and relieved of peak demands by the provision of special gas-making units at the receiving end.

North Thames Gas Board's Policy

Although conditions in this country were different, the policy of the North Thames Gas Board followed the underlying principles which Mr. Hendee had put forward, in so far as they now separated and individually examined the economics of the base load, the seasonal load and the peak load components as affected by their magnitude, duration, and respective load factors.

They recognised that, as a result of wider temperature variations in the U.S.A., the peak-load demand for heat was likely to be relatively greater than in this country, but with the indigenous resources of America in the form of natural gas, coal and oil and refinery gases, excellent opportunity was afforded for dealing with each increment load in the most economic manner. Their American friends were indeed fortunate in having large supplies of propane, butane and gasoline readily available. In this country such supplies were in the main denied to the gas industry, but with further development of the oil industry the position might be changed. At the present time they relied on liquid oil products which were easily gasified and could be stored for long periods at reasonable capital costs. These fuels could be gasified in relatively simple plants, giving large thermal outputs with a minimum labour force.

In the paper, Mr. Hendee had mentioned the Hall process, which appeared to have considerable possibilities for a peak load supply. It would be of interest if he would give some more information on this interesting process, as it did not seem to be generally known in this country.

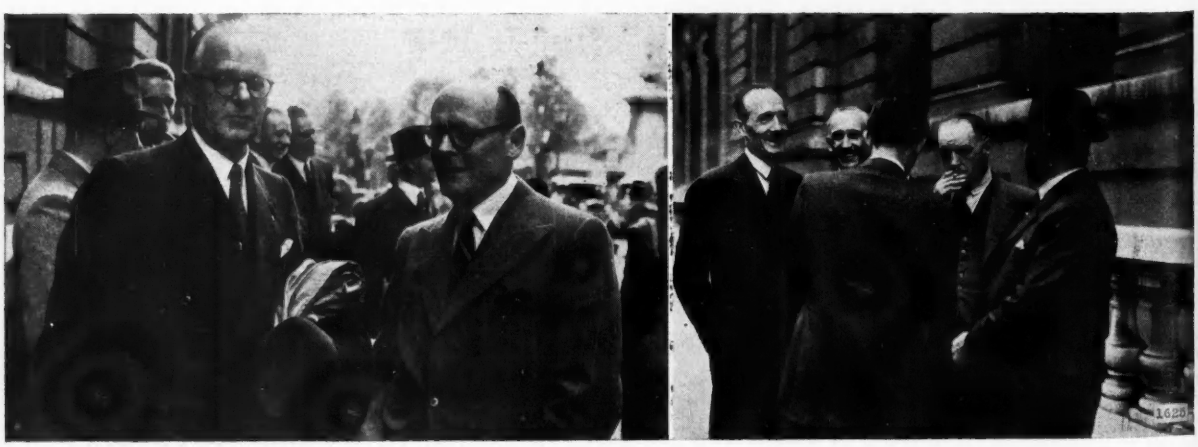
Personally, he was particularly interested in the quantitative assessment of the peak load, and would seek further information about the basis used for expressing the value as a ratio of the maximum and minimum day's demands. It was not their own practice to express this ratio on the actual consumption values, because in this country there could be a very considerable difference in the actual maximum send-out due to the incidence of mild or cold winters. They corrected for these variables by the adoption of standard temperature relationships representing mild, average and severe winter conditions. These were compared with the average daily send-out for the month of June, which month represented minimum heating requirements but was not appreciably masked by the holiday exodus from the cities which characterised the months of July and August. This method of comparison gave them a standard reference for any number of years.

The indications given by Mr. Hendee as to the possibility of materially increasing the capacity of existing plants was of great interest to them; because it might well be that this increase could be obtained at a considerably lower cost and much more expeditiously than by installing new plants. In that connection also, the purification and ancillary processes might well receive consideration, and it would be of interest to learn whether the Americans had also succeeded in stepping up the throughputs of these types of plant. It was, of course, recognised that with the rapidly increasing loads which were now becoming general the policy of extending existing plant capacities could not be relied upon to give more than temporary relief, and large capital expenditure on the whole range of base-load and peak-load plants must be visualised in the near future.

Water Gas Practice

Mr. H. S. Cheetham (Humphreys & Glasgow, Ltd.) said that a debt of gratitude was due to Mr. Hendee for giving a most interesting resumé of what was being done by their American friends in the gas industry. As Mr. Hendee said, they had many interests in common; they also had their common problems, not the least of which was the meeting of the peak load; and it was very interesting to hear Mr. Hendee express the view that in America the problems involved might well be solved by the use of natural gas.

The part of the paper which was of the greatest interest to him personally was that in which reference was made to the separation of the carburetted water gas process into two parts, namely, the independent manufacture of blue water gas in one plant and the manufacture of the enriching oil gas in another. Mr. Hendee said that under American conditions it had been found that where these two portions of the C.W.G. process were carried out simultaneously in one plant, the one imposed limitations on the other. This was no doubt due to the use of heavy oil which, as Mr. Hendee mentioned, might contain up to 13% of what in the U.S.A. was termed coke. In this country, gas oil was used exclusively in the manufacture of carburetted water gas, and, provided that C.W.G. of moderate quality, say not exceeding 500 B.Th.U., was being manufactured, the simultaneous manufacture of blue water gas and oil gas in the same plant did not impose any limitation or bottleneck on either the B.W.G. or the oil gas part of the process, for the combustibles in the generator gas were sufficient to provide the heat required for the gasification of the oil.



British engineers with whom he had discussed these matters, and who had been afforded the opportunity of inspecting the carburetted water gas plants using heavy oil in the U.S.A., had been rather concerned to note the considerable additional equipment with which these heavy oil plants were provided, equipment which in their view it was desirable to avoid in peak-load plant. In some circumstances, where heavy oil having a substantial carbon content was used, they had also been concerned about the labour aspect.

The heavy oil gas process which had been developed by Mr. Edwin Hall had the great merit of usefully employing in the process all the carbon contained in a high coke oil, and it was gratifying to learn from Mr. Hendee that this plant was operating so well. It was now for people in this country to consider to what extent they and their United States friends might be on common ground in the possible advantages of the separation of the processes of blue water gas and oil gas production. The principal points for consideration would seem to be the following:

(1) The price differential between heavy oil and gas oil.
(2) The relative cost of oil and coke.
(3) The additional capital cost of providing separate B.W.G. and oil gas plants.
(4) The extra gas manufacturing cost incurred with heavy oil as a result of the heating, hot storage, and high-pressure pumping and heating and extra treatment of water-gas tar.

Proper appraisal of those factors must take into consideration the local conditions of peak-load gas demand, but in all circumstances it must be noted that:

(a) Owing to freight charges the differential between the cost of heavy oil and gas oil must always be a considerably smaller proportion of the total cost in the United Kingdom than in the U.S.A.
(b) Figures which he had obtained indicated that on a heating value basis the difference between the cost of coke and oil in the U.S.A. was small. In this country the cost of oil was very much greater than that of coke. The President had mentioned in his Address a figure of more than twice the cost of coal.
(c) In the C.W.G. process using gas oil, as practised in this country, the heat required for the gasification of the gas oil was provided by the products resulting from the air blasting of coke in the generator. In the Hall process, oil was used to provide this heat.
(d) In general, it would seem that for the use of heavy oil to be attractive in this country not only must its cost be substantially lower than that of gas oil, but the cost of oil of any variety must be lower in its relation to the price of coke.

He would like again to thank Mr. Hendee for a most interesting paper, which would stimulate all who read it to give a great deal more thought to the various processes involved.

America's Advantages

Mr. Cl. G. Driessen (Chemical Engineer, Delft University: General Manager of the Maastricht Gasworks) said that the author had presented a most important and interesting communication, and all those who had heard it would agree that it was the report of someone who was a specialist in tackling the peak-load problem, a problem with which many of those in the gas industry were now confronted, and a solution of which was possible only with the full co-operation of scientists, technicians, and economists.

The gas industry in the United States was fortunate in possessing the raw materials—coal, oil, and in particular natural gas in unlimited quantities—so that the solution of the peak-load problem in the United States would be simpler than it would be in Western Europe, and especially in the low Countries, which were slowly recovering from a devastating war which had resulted in heavy liabilities, dislocation of the accustomed routine of trade and commerce, and where oil was available only in limited quantities and natural gas was totally unknown.

The peak-load problem in the Netherlands, therefore, was not so easy to solve as in the United States. The oil position in his country, however, was gradually improving. They had been fortunate in finding a few oil wells which were now producing satisfactorily in the East of Holland, and since last year the Royal Dutch Shell organisation had been able to furnish gasworks with propane and butane to increase the amount of gas in winter in order to be able to meet the ever-growing space heating demand.

One difficulty in using liquefied petroleum gases, however, was that the specific gravity was high, and they could not be mixed in unlimited quantities with coke-oven gas, the specific gravity of which in Holland was about 0.3. He would not enlarge, however, on the technical details or conditions of the problem in Holland, as his fellow-countryman Professor Brender à Brandis had given a full report on this to the meeting of the Institution a year ago, and reference might be made to that.

Rational System of Charges

With regard to the economic side of the problem, Mr. Hendee had remarked that the peak-load problem would grow in intensity, and that fundamentally its solution was a matter of economics, which involved rates. Personally, he quite agreed with that view, and he would invite attention to the possibility of preventing peak loads by introducing a rational and attractive system of gas charges. He would suggest the introduction of gas tariffs for summer and winter months. They had been thinking the matter over in his country. If summer tariffs were reduced for some industries or some purposes, this might make it attractive for them to produce more in the summer and thus relieve the winter load. On the other hand, he thought that it was only fair that those consumers who were responsible for the peak-load in winter, and particularly those who used gas for space heating and thus caused a peak load which could only be dealt with by special technical measures and provisions, which were always, as the President had pointed out, very expensive, should pay more for the gas which they consumed.

In conclusion, he would like to refer to what Mr. Hendee had said about the procedure in relation to ceramic plants, which were paying higher than a 'dump load' rate, and where the gas company reserved the right to discontinue service, but would give back to the consumer sufficient free gas to bring his furnaces and the products in them back to the heat which they had when the service was discontinued. It would be very interesting to learn whether in such cases the ceramic plants would receive compensation for damage caused to the furnaces and ceramic products, paid by the respective gas companies. He was quite sure that that would be the case in his own country. In Holland, when in winter there were peak-load troubles industry always had priority.

Alternative Methods

Mr. H. D. Greenwood said that the meeting had been privileged to hear a paper of absorbing interest, and one which was of vital importance to the gas industry. He had noted with interest that both the papers presented to the present meeting were concerned with this problem of peak load, and also that there were several papers devoted wholly or partly to this subject in the programme of the International Conference which was to follow.

Mr. Hendee had shown in his admirable summary that the problem could be tackled in a variety of ways, some of which were not, of course, applicable at the present time in this country. The alternative methods fell into two main groups: (i) to make peak-load gas more cheaply, in which he included storage of gas, and (ii) to reduce the magnitude of the peaks by selection and control of the load.

With regard to the cost of production of peak-load gas, he would call attention to the advantage of alternative heating with coal gas or producer gas. This was general practice in modern coke oven plants and allowed a variation of 100% in gas output. Producer gas heating had generally involved additional costs, and there had been a reluctance to install breeze-burning producers with which producer gas could be made as cheaply as base-load coal gas. Another alternative was to generate producer gas from low grade coal. Where coke-oven gas formed a considerable proportion of the gas supply, he thought that the coke ovens could meet a varying load by combining producer gas and coal gas heating as economically as by varying the throughput of standard gasworks plant together with water-gas production.

Question of Storage

With regard to the question of storage, the methods now being adopted in the U.S.A. were most interesting. During the war he had been very interested in the liquid methane storage plant at Cleveland in the U.S.A., and the unfortunate accident to this plant had hindered development on those lines not only in the U.S.A., but also in this country. He was very glad to learn from Mr. Hendee that work on this method of storage was still going ahead.

A plant had been designed during the war to liquefy natural gas, which was mainly methane, in this country. The design was obtained from the American Company which was responsible for the Cleveland plant. Construction had started when the need to augment our petrol supplies became less urgent, and the scheme was therefore abandoned. The liquid methane was to have been used as a motor fuel, but they always had an eye on its possible use by the gas industry for meeting peak loads.

That brought him to the use of natural and petroleum gases in this country. It was said that 20 mill. tons of crude oil per annum were to be refined in the near future. This would result in large volumes of high calorific value gas. We had also our own natural gas resources; he knew of three natural gas wells—and there were probably more—which it had been estimated by the oil people would yield about 2,000 mill. cu.ft. of methane. It seemed a pity that this gas could not be utilised for meeting peak loads. It was under considerable pressure. When the wells were exhausted, they might be used for underground storage, perhaps for oil gas, as Mr. Hendee said was being done in America.

German Practice

When he was in Germany, they were very interested in the various alternative methods of storage available in the high-pressure gas grid system there, and attempted to analyse the relative economy of low-pressure holders, storage in the pipelines and high-pressure storage. The Ruhr Gas Company had an interesting high-pressure underground storage holder similar to the pipe nests mentioned by Mr. Hendee, and which were stated to be lower in capital cost than any other fabricated storage system. The German plant consisted of 36 horizontal steel pipes about 1,500 ft. long and 15 in. in diameter, laid several feet below the ground. The whole site was covered by an orchard. The capacity of the holder was about 6 mill. cu.ft. at a pressure of 36 atmos. The holder was connected to the high-pressure line from the Ruhr to Frankfurt. The plant was equipped with compressors whereby gas could be pumped from the main to the high-pressure holder, and governors were also provided which automatically fed gas back into the main when the pressure fell below 4 atmos. The cost of this type of holder was slightly greater than that of the low-pressure holder, but when used in conjunction with a high-pressure pipe-line there was little to choose in overall cost between the two types.

Mr. Hendee drew attention to the fact that the cheapest method of meeting peak load was by load selection and control. Personally, he would like to suggest that it was not in the national interest that fuels should be used by industry which involved high production costs and unnecessary capital expenditure, if by the adjustment of industrial production methods this could be avoided.

Balancing Loads

He had also been interested to learn that electric power plants were considered as the best balancing loads in America for natural gas transmission lines. This method had been considered in the Ruhr gas grid, and in connection with some of the large integrated coking and steel plants of the Ruhr, and in certain circumstances had provided an economical solution. In that connection, he would suggest that one of the cheapest sources of peak load gas might be an integrated coke oven and steel plant. Such a plant could change over to oil and producer gas firing when peak-load gas was required and liberate coke-oven gas for distribution.

Mr. W. S. Hubbard (Liverpool) said that during the past four years his undertaking had benefited very considerably as a result of the visits which several members of their staff had made to the United States, and the subsequent correspondence which had taken, and was still taking, place. Not only, therefore, did he consider it an honour to be asked to contribute to the discussion on Mr. Hendee's paper, but he welcomed the opportunity of saying how much they had appreciated this help from America. He would also like to congratulate Mr. Hendee on the skilful way in which he had condensed his subject and at the same time provided so much useful information. The paper did not pretend to give details on how to deal with the peak load problem, but it illustrated the complications attached to sales and manufacture when cheap and abundant gas was available.

The paper was being delivered at a most opportune time, when in this country they were preparing to work in larger groups, and when it could safely be stated that most undertakings, owing to the plant position, could not deal with any serious load expansion. The safest progress which they could make was to take on loads which filled in the trough, and install steadily new plants which formed part of the load below the trough. There was no doubt also that much could still be done to increase the output of existing plants. For example, under certain conditions greater output could be obtained from continuous vertical retorts using an externally-made diluent, and from the facility which many existing C.W.G. plants had to produce a high calorific value gas which could be let down with an externally-made diluent gas with plant at low capital cost.

Widely Varying Characteristics

Mr. Hendee had now drawn attention to a further means of increasing C.W.G. plant output. It did not take much imagination to see that the splitting of the blue gas and cracking functions must lead to higher thermal output. They would look forward with considerable interest to those developments, since they needed every new idea in this direction. They should also note particularly the wide variation in the number of gases distributed in the United States. Obviously the characteristics must vary very widely, but, when considering peak loads and the heavy capital costs now involved in installing plant to produce an all-round uniform gas, one could not be too fussy about peak-load gas. It was necessary to see, however, that all consumers got adequate pressure.

With regard to the use of diluents, he felt that greater use could be made of producers using coals with low swelling properties, or the type of double gas plant now in use on the Continent, several of which he had had the pleasure of inspecting recently. With such machines it was possible to produce a gas, depending on the coals, of a calorific value between 300 and 400, with a total inert gas figure of between 7 and 12%, the gas machine efficiency being of the order of 70%, as compared with 60% with producer gas made in the normal way with coke.

Taking Care of New Load

It was his view that the peak-load problem in this country was a very serious one, and would be more serious if care was not taken immediately with regard to new load. In Liverpool, where the ratio of domestic to industrial use was of the order of 75/25, the ratio of maximum to minimum daily delivery was approaching 2/1, which he would compare with the American figure of 2/1 in 1927 and 3/1 in 1947. However, the amounts of gas involved in the United States were enormous by comparison.

In Liverpool, the gas delivery at any time could be regarded as dependent on three distinct cycles: (a) the daily cycle, (b) the weekly cycle, and (c) the seasonal cycle. Each cycle had its own peaks, and each of the three types of peak gave rise to separate problems.

The daily cycle had hourly peaks, for example, on Sunday morning, Monday morning and Wednesday afternoon. Relatively, these peaks were the highest of the three types, the highest (the Sunday morning peak hour) being on an average 2½ times the mean hourly delivery for the week. However, they generally gave rise to problems of distribution only, which in Liverpool were quite adequately covered by the intermediate high-pressure distribution system now in use, but they were reflected in the steam load position at the works.

The weekly cycle had daily peaks—Monday, Tuesday and Wednesday deliveries, for example, being invariably above the average daily delivery for the week. These peaks were the smallest of the three types, the maximum delivery being only 6% above the average daily delivery for the week. They gave rise to problems of production control which, with reasonable holder capacity and accurate day-to-day delivery forecasts, did not present great difficulties.

The Seasonal Cycle

The seasonal cycle, which produced peaks in January and February and in the week before Christmas, gave rise to problems

of plant capacity. The highest average delivery over a four-weekly period was about 20-30% above the average delivery over the whole year. This could be regarded as the extent of the seasonal variation under normal temperature conditions. Superimposed on this were the additional peaks produced by abnormally low temperatures in individual weeks in January and February. For one of those weeks the delivery could be 30-40% above the yearly average. With reasonably good forecasting of mid-winter deliveries at normal temperatures and estimates of the chances of recurrence of severe cold weather, it could be arranged to have maximum productive capacity available for the shortest possible time to cover such peaks as might reasonably occur.

Only if the absolute maximum productive capacity were known to be inadequate to cover the peaks which might reasonably occur would they have recourse to sales restriction as a policy or to pressure cuts as an expedient. So far at Liverpool, due to increased plant capacity resulting from improved production methods, this state of affairs had not arisen; it had never been necessary to cut pressure, even in the very cold winter of 1947, and their sales policy had been generally one of sales promotion to fill in the troughs rather than one of sales restriction to cut off the peaks.

Study of the peak load problems called for the immediate service of a new type of technician in the industry, namely, a well-qualified statistician. Knowledge of ordinary arithmetical statistics was insufficient, because the work was at such a high level. From experience they had found such a person to be invaluable in deciding production policy; risks could be taken with greater confidence, and plant expenditure more carefully studied and controlled.

He was sure that the paper would be a most useful contribution to the proceedings of the Institution, and, together with the papers to be given on the same subject later in the week by Mr. Birks and Mr. Rose, would provide the American and British standpoints together.

Mr. R. W. Hendee, in reply, said that the hour was late and many people had had to leave, so that he felt safe in saying that he would be glad to send answers or papers dealing with the specific problems which had been raised to anyone who cared to leave his name and address at the Secretary's office. The Hall process, for instance, had been written about very extensively.

The **President** thanked Mr. Hendee for this most generous offer, and the meeting adjourned.

NEW MEMBERS OF THE INSTITUTION

The following were elected as a result of the ballots declared at the opening session of the annual meeting of the Institution of Gas Engineers on June :

Honorary Members (14)

The PRESIDENTS (*ex officio*) of the Gas Associations of Australia, Belgium, Canada, Denmark, France, The Netherlands, New Zealand, Norway, Sweden, Switzerland, and the United States of America.

The PRESIDENT (*ex officio*) of the Coke Oven Managers' Association.

SYLVESTER, A. E., F.C.A., Chairman, The Gas Council.

ZOLLIKOFER, Colonel G. E. H., DIPL.ING., S.J.A., S.S.I.G.E., Secretary-General, International Gas Union.

Members (31)

ANDERSON, R. H., Bradford.
BEDLOE, F. C., Drakes, Ltd.
BISHOP, J., Newton Chambers and Co., Ltd.
BRIGGS, H., Bates and Cook, Ltd.
CHARD, W. A., Gloucester.
CLEGG, J., West's Gas Improvement Co., Ltd.
COLLINS, H. B., Brighton.
COLLINSON, A., Peterborough.
DOBSON, W. E., West's Gas Improvement Co., Ltd.
DONALDSON, G. F., Matlock.
GREEN, A. E., B.SC.(ENG.), Metropolitan Division, S.E. Gas Board.
HENRY, W. C., Shanghai.
HERBERT, S. C., B.SC.(ENG.), Kent Metropolitan Division, S.E. Gas Board.
HINWOOD, B. C., East Greenwich.
HOWELL, A. K., Manchester.
KAY, W., North Thames Gas Board.
LONG, A. C., North Thames Gas Board.
LONG, B., Horley.
PHILLIPS, A. T., North Thames Gas Board.
POLLARD, B., W. J. Jenkins and Co., Ltd.
REED, E. V., Elswick, Newcastle.
SANDERS, A. W., Birmingham.
SMITH, C. M., Devizes.
SPIVEY, E., B.SC., PH.D., North Thames Gas Board.
TAYLOR, H., B.SC., Wrexham.
THICKINS, R. R., Holyhead.
THOMAS, F. K., Limerick.
THOMSON, S. M., A.M.I.MECH.E., Kensal Green.
WAGG, F. C. D., Woodall Duckham Co., Ltd.
WESTBROOK, W. J., Oxford.
WILLIAMS, H. V., Wolverhampton.

Associate Members (87)

ABRAHAMS, H. G., Birmingham.
AITKEN, R. A., Montrose.
BAKER, S. F., Horstmann Gear Co., Ltd.
BARKER, D. S., Southport.
BEARDSHAW, W. E., Cambridge.
BOTTOMLEY, R., Bedford.
BOWN, C. P., Accrington.
BOYS, H. W., Brighton.
BREMNER, H. J., North Thames Gas Board.
BROOKS, G. W., B.SC.(LOND.), Wilsons and Mathiesons, Ltd.
BROWN, B. D., Aberdeen.
BROWNLEE, J., Newcastle.
BUBB, S. H., Birmingham.
BUCKHAM, S. G. G., Brighton.
BUNKER, P. J., Brighton.
CAMPBELL, A., Inchgreen, Greenock.
CAPEWELL, F., International Furnace Equipment Co., Ltd., Aldridge, Staffordshire.
CONNOR, D. H., Southampton.
COOKSON, G. C., B.SC., Saltley, Birmingham.
COX, D., Rushden.
DOBSON, W. E., Coventry.
EDWARDS, K. R., Bournemouth.
EVANS, K. N., Jersey.
FARMER, G. C., Lea Bridge.
FENDER, B. L., Metropolitan Division, S.E. Gas Board.
FIELDER, H. L., B.SC., Worcester.
FITZSIMONS, W. A., Bradford.
GEALL, D. G., Brighton.
GOODWIN, G. H., Beverley.
GOTHERIDGE, N., B.SC., Woking.
GROGONO, N. D., M.A., A.M.I.C.E., Woodall Duckham Co., Ltd.
GROVES, D. F. W., North Thames Gas Board.
HAMMOND, D. H. P., Exeter.
HATHAWAY, W. L., Oldbury.
HERBERT, K., Manchester.
HILL, R. A., Bournemouth.
HIRST, C. H., Southport.
HODGSON, R., Bradford.
HOLLIS, W. H., B.SC., Power Gas Corporation.
HUTCHINS, A. V. S., Neath.
IRVIN, S. G., B.SC., Newcastle.
JENKINS, D., Richard Thomas and Baldwins, Ltd.
JOHNSON, H., Altham Coking Plant, National Coal Board.
KIMBLE, R., Birmingham.
KING, F. H., Salford.
KNIGHT, B. R., Brighton.
LANE, W. T., Torquay.
LOWIS, J. B., Oxford.
MALE, W. L., Blyth.
MARFLEET, S. R., Tottenham.
MARSH, R., Exeter.
MCSWEENEY, T. D., Metropolitan Division, S.E. Gas Board.
MOORLEY, T. E., Oxford.
O'CONNOR, A. T., Rushden.
OWEN, E. C., Birmingham.
PARKER, W. J., B.SC.(LOND.), Standard Brick and Sand Co., Ltd.
PERKS, H. A., Birmingham.
PIGGINS, H. B., Bolton.
PIGGOTT, K. L., Stroud.
PINK, D., Tottenham.
PRATT, E. B., Metropolitan Division, S.E. Gas Board.
RICKARD, C. H., Leeds.
RICKETTS, A. J., Redditch.
ROSE, W., Kilmarnock.
SHARPE, R. M., Boston.
SHARROCK, R., Liverpool.
SKINNER, L. F., Tottenham.
SMITH, J. B. M., Vale of Leven.
SUCKLING, J. R., North Thames Gas Board.
SWEET, W. S., Ascot.
TAYLOR, D. V., Liverpool.
TAYLOR, V. T., Gas Research Board.
THRUPP, T. H., Rossendale.
TUBMAN E. J., Metropolitan Division, S.E. Gas Board.
WATSON, J., Dundee.
WATSON, R. W., Birmingham.
WELLINGTON, M., Port Talbot.
WELLS, R., Tottenham.
WELSH, J. H., Birmingham.
WESTON, R. G., Chelmsford.
WHITE, L. F., Wellington.
WHITEHEAD, C., Middlesbrough.
WILSON, A. G., Salford.
WILSON, B. E., Loughborough.
WINTERBURN, A. G., Tottenham.
WOODS, A. H., Watford.
WOOD, M. S., Birmingham.

Associates (27)

BRANCH, M. A., Kingston.
BROWN, T., M.COM., S.E. Gas Board.
CHALLIS, G. H., A.M.I.CHEM.E., Whessoe, Ltd.
COPE, W. A., Northampton.
DEANS, T. G., Sunderland.
DENMAN, G. W., Swanage.
EDGAR, J., Mirfield.
ELLIS, W. D., Uxbridge.
ESKIN, S. G., Robertshaw-Fulton Controls Co.
GOW, J., Newcastle.
HALLIDAY, S., Parkinson and Gowan (Gas Meters), Ltd.
HALSTEAD, C., Blackburn.
HENDERSON, D. C., Bradford.
INGHAM, W., Millom.
KINNAIRD, D. H., Derby.
LAWSON, T. W., Sunderland.
LIPPETT, L. G., Folkestone.
MCALISTER, G. A., Metropolitan Division, S.E. Gas Board.
PATTERSON, W. W., Bishop's Stortford.
RUSHTON, G. R., Buckie.
SCOTT, W., Hamilton.
STEER, L. C., Ascot.
THOMAS, G. W., Rushden.
WATERMAN, F. A., North Thames Gas Board.
WELDON, W. R., Greenock.
WESTLAKE, A. G., Falmouth.
WORTHINGTON, F. J., Honiton.

NATIONALISATION AND THE INDIVIDUAL*

AN EXPERIMENT IN LARGE-SCALE ORGANISATION

By A. E. SYLVESTER, F.C.A.,
Chairman of the Gas Council.

WHEN I was invited by your President as long ago as August last to speak to you on this occasion, I accepted gladly. I imagined that this meeting would take place soon after vesting date, and that it might well afford an excellent opportunity for speaking to you about the situation as it had developed. At the same time, I hesitated to give so far ahead a title for my address because it was impossible to foresee just what would happen and what the situation would in fact be. We now know a good deal more than we did last August. We know that the industry passed into State ownership nearly two months ago and that the change-over took place with remarkable smoothness. For this, credit must be given not only to the excellent preparations made by the area Boards, but to the loyal co-operation of all ranks in the industry.

You will, therefore, I think, readily appreciate my reason for choosing as the subject matter of my address a subject which I believe as time goes by must become a vital one, not only for our industry, but for the country at large.

Future of the Industry

I feel that our time can be spent to better advantage if we look ahead into the future and particularly if we look ahead as individuals, and I am sure you will understand that it implies no lack of confidence in you, no thought of secrecy, that I turn aside from the actualities of the moment and embark upon a somewhat less tangible subject. After all, the new régime has hardly settled down and quite a lot has been said of what we propose to do. It is far better at the present time to get on with the job and come back to the subject of the progress of the industry when we can give some account of what has in fact been done. So, for these reasons, and I hope you will think they have some weight, I propose to speak to you on the subject of 'Nationalisation and the Individual.'

The word 'nationalisation' means the conversion of an industry or service into national property. That is correct so far as it goes, but it does not go far enough. Once you take away any question of public ownership, nationalisation can mean so many different forms of nationalisation as, indeed, we have seen in the industries that have passed into public ownership during the last few years. We can say of nationalisation then that it is a series of experiments in the organisation of modern industry. Apart from the fact that ownership has been transferred from the hands of private enterprise into those of the State, the problems of conducting a nationalised industry are neither more nor less than the problems which confront those who have to conduct any large-scale organisation.

Importance of the Individual

For the purpose of this address, therefore, I do not propose to attempt to give you a definition of nationalisation, or to speak on nationalisation at large, but to relate anything I have to say to the present shape and form of the gas industry.

During the 19th and 18th centuries the ideal that was perhaps most often before the eyes of men was that of freedom. 'We must be free or die, who speak the tongue that Shakespeare spake . . . .' wrote Wordsworth, and the sentiment was echoed by countless worshippers of liberty. Today we seem collectively to have moved towards the worship of a different ideal—equality—while at the same time, the power of the State and of the large organisations—not necessarily under public ownership—against the individual seems to be increasing. I feel that there is a danger here which we must recognise and guard against, and I have been much struck recently to find three eminent modern thinkers have been insistent on the importance of the individual in civilised communities.

The first of these three men is Bertrand Russell, who approaches the problem as a philosopher. For the recent series of brilliant lectures he gave over the air—the first of the B.C.C.'s Reith Lectures—he chose as his title 'Authority and the Individual.' 'If life is to be saved from boredom, relieved only by disaster,' he said, 'means must be found of restoring individual initiative, not only in things that are trivial, but in the things that really matter.' This sentence is crisp. It cracks like a pistol shot.

Society as a Field of Action

Then we find the well-known historian, Professor Arnold Toynbee, saying in his 'Study of History'—'A society is a product of the relations between individuals, and these relations of theirs arise from the coincidence of their individual fields of action. This coincidence combines the individual fields into a common ground, and this common ground is what we call a society.'

Toynbee goes on to point out that a society is a 'field of action,' but the source of all action is in the individuals comprising it. 'Growth,' he says, 'is the work of creative personalities and creative minorities'; but mark this well, 'they cannot go on moving forward themselves unless they can contrive to carry their fellows with them in their advance; and the uncreative rank and file of mankind, which is always the overwhelming majority, cannot be transfigured *en masse* and raised to the stature of their leaders in the twinkling of an eye.'

Finally, we have a man eminent in the field of modern literature, T. S. Eliot, pointing out in his 'Notes Toward the Definition of Culture' that the culture of the individual cannot be separated from that of the group, and that the culture of the group cannot be abstracted from that of the whole society. 'It is only,' he adds, 'by an overlapping and sharing of interests, by participation and mutual appreciation, that the cohesion necessary for culture can obtain.'

Development of the Creative Spirit

So you see that here are three of our leading thinkers each from his own standpoint, philosophy, history, and literature, emphasising the importance of the individual in modern life, and from each of the quotations I have given you from their works we can, I believe, learn something which will be of inestimable benefit to us and to the future development of our industry. Just as in the larger world of nations and societies, our organisation must depend for its development on the creative spirit of the individuals who comprise it, and on the co-operation between those individuals for the common good.

The gas industry has been developed over a long period—nearly a century and a quarter—by individuals, mostly engineers, controlling a large number of separate units. Those engineers have not been restricted. Indeed, they have enjoyed a large measure of latitude in the exercise of individual responsibility both as regards the methods of gas manufacture adopted by their undertakings, and the methods of distributing the gas so made. There is no doubt—there can be no doubt—that this exercise of

* An Address (Communication No. 351) to the Institution of Gas Engineers London, June 14, 1949

individual and local pride in the efficiency of each unit has worked towards the general good of the industry.

Reputation for Team Work

At the same time, the gas industry has always enjoyed a good reputation for team work. It was the first British industry to launch a co-operative organisation for publicity and educational work, and its member undertakings have always been alive to the importance of working together on matters affecting the development of our industry as a whole and the welfare of the consumers of gas.

Now the whole organisation of the industry has been changed. In place of the thousand or so separate gas undertakings there are 12 area Boards, which, together with the Gas Council, form the administrative units of the industry. But this change should not mean—it must not mean—that the task of the gas industry is any other than what it has always been, to provide the community with an efficient and economical service. The industry will continue to prosper to the extent to which that service is provided well and faithfully.

Not only that, but the change which has taken place in the organisation of the industry need not involve the suppression of initiative and individual effort. Indeed, it would be a tragedy if it were to have the effect of making those employed in the gas industry sit back and wait to be told what to do. As I said before, we are sharing in an experiment in large-scale organisation, and it is up to every one of us to show that in our own industry the individual can act as productively and efficiently under the new régime as he was able to do under the old. A healthy and progressive organisation must have individual and local initiative in addition to a measure of central control. That some control is necessary is obvious, for without it there would be confusion and irresponsibility; initiative is equally essential for, unless there is initiative, there is stagnation, and the lesson which history teaches us is that in every department of life we cannot remain stationary. The only alternative to progression is retrogression. We must go forward or fall back.

Delegation of Authority

We are, I think, fortunate in the gas industry in that the organisation set up by the Gas Act embodies a greater degree of decentralisation than that of other industries coming under State control, and thus gives wider opportunities for the development of individual enterprise. The autonomy enjoyed by the 12 area Boards will, I hope, allow for a full delegation of authority throughout the whole industry. 'It must,' to quote Bertrand Russell again, 'be an essential feature of any wholesome system that as much as possible of the power should be in the hands of the men who are interested in the work to be done.'

I will ask you to note the concluding words of that last sentence, 'interested in the work to be done.' Pride in one's work, whatever that work may be, is to my mind the best incentive a man can have. Every man of an energetic mind looks to find something more in his job than security and the regular return of pay day. Pride in his job gives a man self-respect and self-confidence, both qualities which are essential to achievement for, as someone, I think it was Samuel Butler, has said in his ironical way, 'all success is built from a scaffolding of conceit.' He also said, still more ironically: 'No country is without honour, save in its own prophets.' This is somewhat off the beam, perhaps, but it is well worth bearing in mind.

Merely a Change of Name

I might mention, too, an interesting inquiry made recently at a technical college in one of our large cities. A number of men who had been attending an industrial course were asked to list in order the conditions which they hoped to find in a job. First on the list of desirable conditions were security and a good pension scheme. Only in the fifth place on the list came the interest of the job itself and the initiative and skill one could put into it. No higher than ninth on the list came good chances of promotion. I submit that an industry in which the workers place security higher than ambition as an ideal is incapable of development to its full extent. That does not display the man of energetic mind we hope to find in our industry. It is not the spirit which has operated among gas undertakings in past years; nor will it, I hope, operate in the future.

Provided, then, that a man has that pride and interest in his work, that capacity to bring about results, which have distinguished the gas engineers of both large and small undertakings in the past, does it really matter whether he makes his reports to a board of directors, to a gas committee of a local authority, or to an area Board? I suggest to the majority of those employed in our industry the change which took place at midnight on April 30 last was a change merely of name and not a change of job. The job continues with the same scope for enthusiasm, enterprise and initiative as we offered before.

The Danger of Indifference

To those who have been selected for more important posts, I would say: 'Do not think so much of the added status that your new position gives you; think rather of its added responsibility. At the same time, be ready to delegate responsibility so far as this can properly be done to the local management and staffs.' Where the source of control is regarded as a remote body, far removed from the man on the job, there is a danger that loyalty and the spirit of incentive will be replaced by fatalism and indifference. This is a danger which it particularly behoves us to guard against at the present stage in the gas industry's development.

There is an old proverb, 'Look after the pence and the pounds will look after themselves.' I shall not go so far as to say that this can be translated into 'Look after the individuals and the organisation will look after itself,' but there is more than a germ of truth in that adaptation. We must look after the individual in so far as we give him opportunities for initiative; we must make conditions of work in the gas industry sufficiently attractive to induce a steady supply of well trained recruits to enter the industry, and we must look after the education of the individual once he has taken employment in the industry. Here I can pay tribute to the new Educational Scheme of the Institution which should at one and the same time attract the best possible type of entrant to the technical side of the industry, and ensure a higher standard of ability in those entrants. Apart from the engineering side—and our industry must from its very nature largely be manned by engineers—there is the need for the trained specialist in non-engineering subjects. The widening scope of our industry today calls for the increasing employment of experts in every branch of its activities. Our business is not only to make gas, but to sell it, and to give the public that expert advice and assistance which will enable every class of consumer to get the best value from the gas for the particular purpose for which it is used. You do not need to be told that the most efficient gas manufacturing practice is nullified unless it is supported by efficient distribution and a well planned sale policy. Moreover, the fuel problems of the world are changing from day to day as a result of scientific discoveries and engineering skill. Every technical advance involves new methods of distribution and utilisation. It is only by the employment of trained specialists in distribution, and selling, that the industry can develop. Here I need hardly remind you that the facilities for research must play an increasing part in our activities. Research into improved methods of manufacture and into more efficient ways of utilising gas and the products of gas making is a most valuable spur to progress.

Recruitment, Training, and Education

By specialisation I do not mean a series of experts each working in his own self-contained sphere without regard for what the other people in the team are doing. Opportunities for co-operation and the interchange of ideas are certainly no less important in our new organisation than they were before May 1. Perhaps at this point I might touch on another factor in the development of the gas industry—the personal quality of the men and women who represent the industry to its consumers. When one considers that there are over 11 mill. consumers of gas and that the supply of gas to each one of them involves a personal relationship between the consumer and the undertaking, the human touch is obviously all-important. In this country people are somewhat suspicious of bureaucratic methods whatever claims may be made for their efficiency. They judge the character of any organisation from the attitude of its individual employees with whom they come in touch. That is an added reason for the recruitment of the best type of employees and for training and education to fit them for their work and to give them an understanding of the purpose of the organisation to which they belong. Training and education are also most important for they enable the doors of opportunity to be opened wide, so that people can rise to positions of the highest responsibility.

In this work of maintaining good public relations, we may expect to receive valuable assistance from the consumers' Consultative Councils which have been set up under the Gas Act.

There is one such Council attached to each area Board and its function will be two fold: to assist the Board in making known its policy to the public, and to keep the Board informed in turn of the public's needs.

As I have already said, the Boards will be for all practical purposes supreme in their own areas, while, through the Gas Council, they will have an opportunity for consultation and the exchange of views. This set-up should result in the best possible form of organisation in each area, for it enables each Board to study the actual job before it and to shape its organisation in accordance with that job. In other words, the structure is being built from the ground upwards instead of from the top downwards—always the most efficient and satisfactory form of building whatever the edifice.

While the area Boards have autonomy in their own spheres, they may, under the Act, be given directives by the Ministry of Fuel and Power on matters of national interest. In this connection it is interesting to consider five principles put forward recently by the Minister as a basis for a long-term national fuel policy. They are as follows:

1. That consumers should have freedom of choice.
2. That consumers should be given adequate information on which to base their choice.
3. That the price of the various forms of fuel should broadly reflect the cost of producing them.
4. That as far as possible nuisance from smoke and grit must be eliminated.
5. That there must be sufficient co-ordination, both of production and consumption, to ensure maximum efficiency and lowest costs.

None of these principles will cause a face to blench in the gas industry; indeed, we welcome them as an assurance for the future, in the confidence that gas will be able to play an increasing part in the service of the community. The industry has behind it a long and proud record of expanding public service, but its opportunities in the years to come are no less great. To mention but one branch of the industry's activities, even today, in spite of the industry's advances that have been made in this field, the industrial gas load represents only a fraction of what it could—and should be. On the domestic side too, the gas industry with its two smokeless fuels, is admirably placed to provide the higher standards of heat services recommended by Government committees. Every individual in the industry, therefore, whatever his job, should be conscious that he is engaged on work of national importance and that he is making a contribution towards the comfort and well-being of the whole community. If we can maintain that spirit of service that has animated our industry throughout its long career, we are not likely to fall short in our endeavours.

We should therefore approach the future with confidence and a determination to show that the individual can continue to display the same qualities of enterprise, enthusiasm and loyalty, and that the new gas industry, which is the sum total of the individuals comprising it, can rise to even greater heights than before.

And so we reach the end of my address. I have tried to impress upon you the vital importance of the individual. The future of our industry depends on your response, and of that response there can be no doubt.

As I write these closing phrases, a sentence springs to my mind, It comes from that Great Book to which we turn all too infrequently. There, in six short words written by St. Paul, lies the heart of the matter—'Quit you like men, be strong.'

INSTITUTION BENEVOLENT FUND

A GENERAL meeting of the contributors to the Benevolent Fund of the Institution was held on Tuesday, June 14, Mr. **E. Crowther,** Chairman of the Committee of Management, presiding.

The **Chairman** moved the adoption of the Report of the Committee of Management of the Benevolent Fund for the year 1948-49 and accounts for the year 1948.

Dr. H. Hollings seconded the motion, which was carried.

The Hon. Secretary (Dr. W. T. K. Braunholtz) announced that the scrutineers of the ballot for elections to the Committee of Management for 1949-52 had reported that Mr. James Carr (Bristol) and Mr. J. Hunter Rioch (Cambridge) had been duly elected.

Mr. J. H. Dyde, in moving that the Institution of Gas Engineers be appointed a trustee of the Benevolent Fund in the place of the late Mr. Henry Woodall, said that in recent years the Benevolent Fund had suffered the regrettable loss of two eminent men who had acted as trustees—namely, Sir David Milne-Watson and Mr. Henry Woodall, and the meeting now had to elect a trustee to serve in place of Mr. Woodall. It had been suggested that it would be a considerable advantage if the Institution itself was appointed a trustee.

Mr. F. Dawson seconded the motion.

Amendment of Rules

The Chairman then moved the following resolution to effect modifications in the Rules of the Fund :—

'That there shall be added to existing Rule 7 the following words—namely, "by the Committee in the names of the trustees in any investment for the time being authorised by law for the investment of trust monies with power for the Committee to change such investments for others of a like nature provided always that with the previous sanction of a general meeting any such monies as aforesaid may be invested in and any such investments as aforesaid may be changed for any investments selected by the Committee notwithstanding that such latter investments are not otherwise authorised by law for the investment of trust monies."

'That existing Rule 21 shall be cancelled and the following Rule shall be inserted in lieu thereof—namely, "The Committee shall not grant any pensions and shall not make or promise to make any grants or payments to beneficiaries in such manner as to appropriate or anticipate the future income of the Fund."'

With the notice convening the meeting, he said, there had been sent to contributors an explanatory letter, indicating the purpose of and the reason for the proposed amendments. The position, as explained in that letter, was that the Committee of Management desired to participate in a company known as Crossways Trust, Ltd., an organisation which provided and maintained homes or hostels for persons in need of such accommodation, whether by reason of age, infirmity, or lack of means. A number of organisations with objects broadly similar to those of the Benevolent Fund of the Institution had come together in this project. Each made a contribution or a loan, as the case might be, to the Crossways Trust and in consequence became entitled to nominate a person or persons to occupy the accommodation provided by the Trust. The Committee of Management, desiring to participate in the Trust, found it necessary for the Rules to be amended before that could be done, as it was informed by its legal adviser that the present powers of investment did not cover the making of a loan, still less of a donation, to such a trust.

Lieut.-Colonel J. A. Gould seconded the resolution, which was carried.

Vote of Thanks

Lieut.-Colonel F. J. Bywater then moved a vote of thanks to the Chairman, the Committee of Management, and the Hon. Secretaries of the Benevolent Fund, Dr. Braunholtz and Mr. Terrace, for the work which they had done on behalf of the Fund during the past year. All the cases which came before the Committee, some of which were very distressing, were enquired into with the discretion and privacy which were essential in dealing with such matters. He was sure the contributors would be glad to know that the Committee was not allowing its work to flag, but was asking for more money, so as to extend its work and make it still more useful. During the past year the Committee had managed to increase the grants made from the Fund. He thought that the Committee of Management and the Hon. Secretaries must derive some satisfaction from the valuable work which they did for the Benevolent Fund and, to a lesser degree, all the contributors must derive some satisfaction from reading the report.

Mr. **R. B. Glover,** in seconding the vote, said it would be of great assistance to those who operated the Fund if the contributors would return their forms promptly.

The **Chairman** said that his own duties in connection with the Fund were of a very short-lived nature, and he would therefore ask Dr. Braunholtz, whose work for the Fund continued from year to year, to acknowledge the vote of thanks.

Dr. **Braunholtz** said he would like to tell all the contributors to the Fund how very much their contributions were appreciated, particularly when they were made by deed of covenant. The Benevolent Fund still needed more money, because, although it was doing all it could for its beneficiaries, owing to the great increase in the cost of living many of them were finding it extremely difficult to keep body and soul together.

A BACKGROUND TO SOME ECONOMIC PROBLEMS IN THE GAS INDUSTRY*

BY D. G. ROSE, B.Sc.(Econ.), COKE MANAGER, NORTH THAMES GAS BOARD

THE past few years have seen a new approach to a number of long-term economic problems which face the gas industry and other public utilities engaged in the supply of heat and energy. It starts from an appreciation of important differences in the characteristics of consumer demand, according to the purpose for which the fuel is being used. These differences are important because their repercussions on the production side give rise to special elements of cost.

To the consumer and, perhaps, to the salesman also, it may be a matter of surprise that any attempt should be made to discriminate between two units of a closely standardised product. To the consumer it would seem that one therm of gas is as good as another, and it is nobody's business but his own to what use he puts them; why should he not choose his own time and place and purpose? The production engineer, on the other hand, cannot fail to see a very big difference between therms produced under steady conditions and those extra ones which he strives to produce in order not to fail on the peak load.

It is a complex problem and one which presents very different aspects to the consumer, the salesman, and the engineer. For one thing, the production engineer is concerned with consumers in the aggregate, or, as he might say, with the 'average consumer.' The salesman knows that there is no such person or entity; consumers are individuals, each of his own habits and personality and, seeing no reason for supposing that one therm is better than another, is entitled to think that for average gas he should pay a standard price. From the salesman's point of view, surely the winter is just the time to sell the gas.

How can we reconcile two very acceptable principles,

(*a*) that a standardised product should be sold at a common price, and,

(*b*) that price should be related fairly to cost?

It is a problem not by any means new or confined to public utilities, although with them it arises in a special form. It is perhaps the chief of the problems to which their existence gives rise and has had a big influence on the design of the statutory framework within which they operate. Their products being relatively non-transferable, since they consist of services supplied by means of fixed rails, pipes, wires, and so on, the only competition they need fear, as a rule, is from substitutes. This, combined with the possibility of dividing consumers into classes, opens the way for discriminatory charging. Such discrimination is widely practised and not only by railways. To give an opinion on whether this is right or wrong would be to break from economics into ethics, and that is not the purpose of this paper; but it is mentioned to show that there is nothing new in treating two therms as different commodities economically. The big difference to be borne in mind is that in the present problem we are discriminating between uses and not between consumers; between costs of production and supply and not 'what the traffic will bear.' But the point is more generally appreciated to-day than it was formerly. Post-war conditions have demonstrated to consumer and producer alike more clearly and quickly than any formal reasoning could possibly do, just where the distinction lies. 'Load-shedding' and appeals to the public to economise in the use of electricity and gas at times of peak load have now been supplemented by an increased charge for electricity during the winter months.

Mr. F. M. Birks has drawn attention† to the powerful reasons which exist for preserving a clear distinction between 'seasonal' loads and base loads and the implications of an unbalanced development in the former. As a means to a full understanding, he strongly advocates the use of a simple method of representing load characteristics on a single-line chart, and he has made a plea for the interchange of experience and data. This paper is an attempt to describe the underlying relationship between atmospheric temperature and gas consumption, as seen in a study of the data available in the Gas Light and Coke Company, and some of the uses which can be made of it. It is presented in the hope that it will help a wider circle to understand the problem.

* Publication No. 352 of the Institution of Gas Engineers.

† Presidential Addresses to Fuel Luncheon Club, 1947 and 1948.

that it will provide means of comparing the load characteristics of different undertakings and of analysing business trends, and that it will suggest a basis for stock control and the longer-period planning of production in large undertakings.

This is a statistical study, but in order that as many as possible may follow the reasoning, the use of statistical terms and mathematics is avoided as far as possible in favour of graphical methods. First of all let us keep in mind three principles:—

(1) The problem is to put single events together in such a way that they will point to the underlying relationship, or in concise manner define the major forces which act upon them.

(2) The job must be done with the utmost economy in data, not only because of the work involved, but because, if one goes on too long, there is the danger of other influences getting to work.

(3) By reason of (2) we are working necessarily with small samples and must beware of the fallacy of reading more into the results than they contain. The best method will be the one which combines accuracy with economy of data.

It will be readily appreciated that 'other influences' have been so numerous and followed each other so quickly during the past few years that it is necessary to go back to 1938 to find adequate and homogeneous data available for analysis. In the data of 1938, we can observe the effect of atmospheric temperature changes with a reasonable assurance that the variations are free from other influences.

Variations in Rate of Consumption

The volume of gas sent out daily from the works of the Gas Light and Coke Company in 1938 ranged from rather less than 100 mill. cu.ft. to 265 mill. cu.ft.‡ For the benefit of those unfamiliar with the main features of the Company's production and distribution system, it may be mentioned that those volumes were contributed by 13 gas-making stations with the help of outlying storage stations, and distributed among a population of 3½ mill. people over an area of 540 sq. miles.§ Synchronised hourly readings of works meter indices and holders provide reliable data of the volume of gas made, consumed, and held in stock. The hourly volumes are 'uncorrected,' but for each 24 hr. ended 6 a.m. the day's total production is adjusted to standard conditions of temperature (60°F.) and pressure (30 in. w.g.). No similar adjustment is made to stock, but the errors from this source are relatively small, and although present when atmospheric conditions undergo violent change they cancel out over a rather longer period.

Consumption of gas is a continuous process, going on at an ever-changing rate which reflects the habits of consumers and the way in which they adapt themselves to seasonal changes. It is a curious combination of the solar and the secular. Thus there are three very definite time cycles which, though differing in detail, may be found in the data of all undertakings.

First, the diurnal variation covering the change from hour to hour. The shape of the typical hourly curve shown in Fig. 1 is too well known to call for further comment here.

Secondly, the seven-day cycle which covers those differences in day-to-day totals that are associated with the working week. These differences will show considerable variation between under-

‡ 1 cu. ft.=0.0283 cu. m.

§ 1 sq. mile=1.59 sq. km.

takings and over a period for the same undertakings. In the data considered, daily consumption on Saturdays and Sundays is less on weekdays. The weekdays show some variation

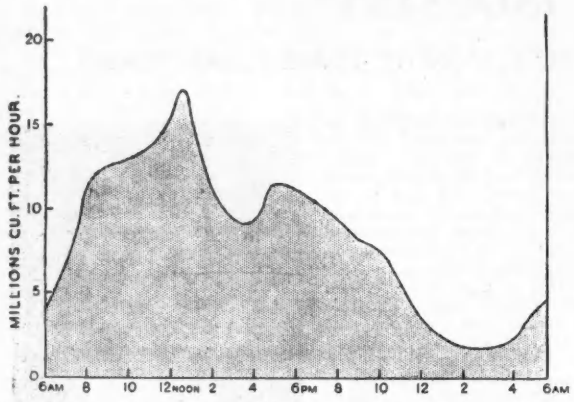


Fig. 1.—Hourly rate of gas consumption on a typical weekday—Wednesday, Jan. 5, 1938.

between themselves, Monday being the heaviest, but the differences are small, and for many purposes it is convenient to group them together. Fig. 2 is a diagram of daily sendout and temperature for the month of December, 1938. That month is particularly interesting, for it provides an excellent example of the consequences of a sudden change in temperature. Particular note should be made of the immediate response of consumers to the sharp fall in temperature that occurred during the week-end December 17/18. Consumption on Monday, the 19th, was greater by 70 mill. cu.ft. than on Saturday, the 17th, and further increases occurred on the two days which followed. A short time lag between cause and effect can be detected in so far as consumption underwent a small increase after the weather had turned slightly warmer on Dec. 21. This chart also illustrates what contrasts can be concealed in an average. Taken over the whole month the temperature was normal, but only because the unusually mild beginning was balanced by the later cold snap. The week-end fall in consumption is conspicuous.

The manufacture of gas proceeds much more steadily. In the long run, of course, it matches consumption, but storage space and stock look after the short-term cycles and absorb the first effects of sudden changes in weather.

These two consumption cycles, the daily and weekly, are reflected in the gas stock cycle represented in Fig. 3 in the graphical form which has served as the basis of the method of stock regulation used in the Company's Control Room at Westminster since 1940. The method makes use of the fact that at any time of day the difference between cumulative totals of production and consumption, starting from 6 a.m., are equal to the change in stock over the same period. Advance estimates of consumption based on the latest weather forecasts are considered together with available manufacturing capacity and storage, and production is arranged accordingly. The fine control that can be exercised on the production system as a whole can be gauged from the daily stock peaks in relation to the available storage capacity. At the time (this chart relates to January, 1946) both storage and manufacturing capacity left so little margin that it was imperative to maintain a high stock especially during the early part of the week. It will be seen that the stock was deliberately reduced prior to the weekend, but was restored by Monday morning.

Thirdly, there is the annual cycle which reflects seasonal trends in atmospheric temperature, but includes the effects of holidays as well. That part of consumer demand which is dependent on temperature is as changeable as the weather itself, but even this over a period does conform to a pattern.

The ratio of 'seasonal' load to total load varies considerably between undertakings, but, in this country at least, the changes associated with temperature are so large as to make it very difficult to observe at all closely the effects of other factors such as those which go to make up the general trend of business.

The problems arising from day to day variations, especially those connected with the weather, are of two types: short-term practical problems like the control of gas stock and the long-term problems, mainly economic in character, which are associated with the ratio of the actual output from the plant compared with its potential output—that is to say, its load factor. It is in the latter connection that Mr. F. M. Birks has referred to the use of a 'single-line chart,' and it is appropriate to bring it in at this point. Whatever the time interval being considered, we can by its use show the entire data for the year in one simple chart. In their normal sequence, as typified in Figs. 1 and 2, the crude hourly and daily data exhibit such rapid change that it is difficult to assess the nature of their variation. Naturally enough, one tends to represent them by average values. In the case of the gas industry, thanks to the distribution system, the producing plant is independent of hourly variation in consumption and operates relatively steadily at a rate which tends to consumption averaged over 24 hr., or even a week. Unfortunately, averages mask the range of variation between the extremes which assume such importance in that they determine plant requirements whether for distribution or production. Although the average is the measure of total load, this has to be considered in relation to the maximum value. If the data are arranged in ascending/

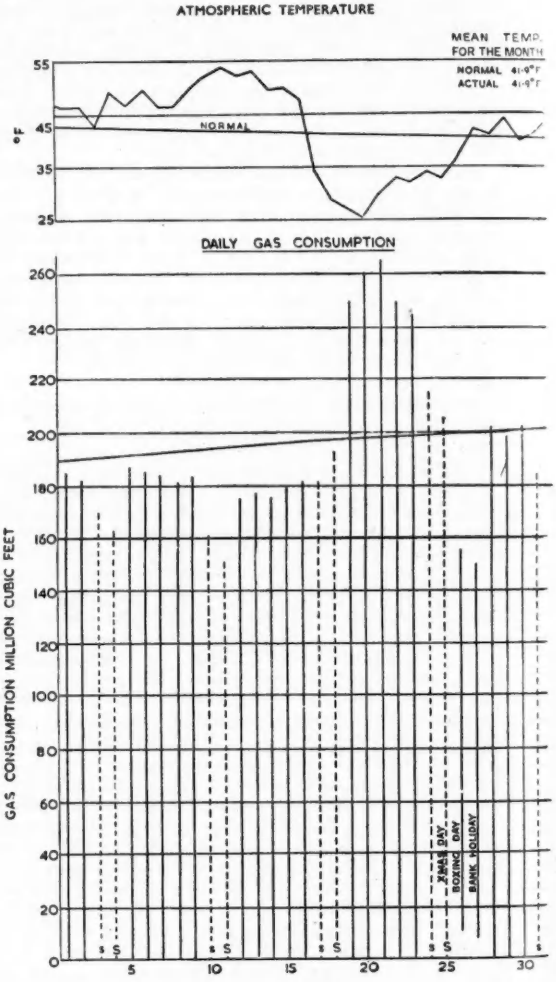


Fig. 2.—Mean temperature and daily gas consumption for December, 1938.

descending order (from the lowest to the highest) the resulting single-line frequency distribution is in a form in which the eye can readily assess the load characteristics. In Figs. 4a to 4d this method is applied to hourly, daily, weekly and quarterly arrangements. The first (Fig. 4a), is made up of the original hourly figures for 1938 arranged in ascending order. As there are 8,760 of them they present here a smooth line ranging from the lowest night hour to the maximum dinner hour on the coldest Sunday or Christmas Day. This first illustration sums up the distribution problem, and, as Mr. F. M. Birks has suggested, may have application to the data of the electricity supply industry. Fig. 4b is the 365 daily volumes arranged in their order of magnitude.

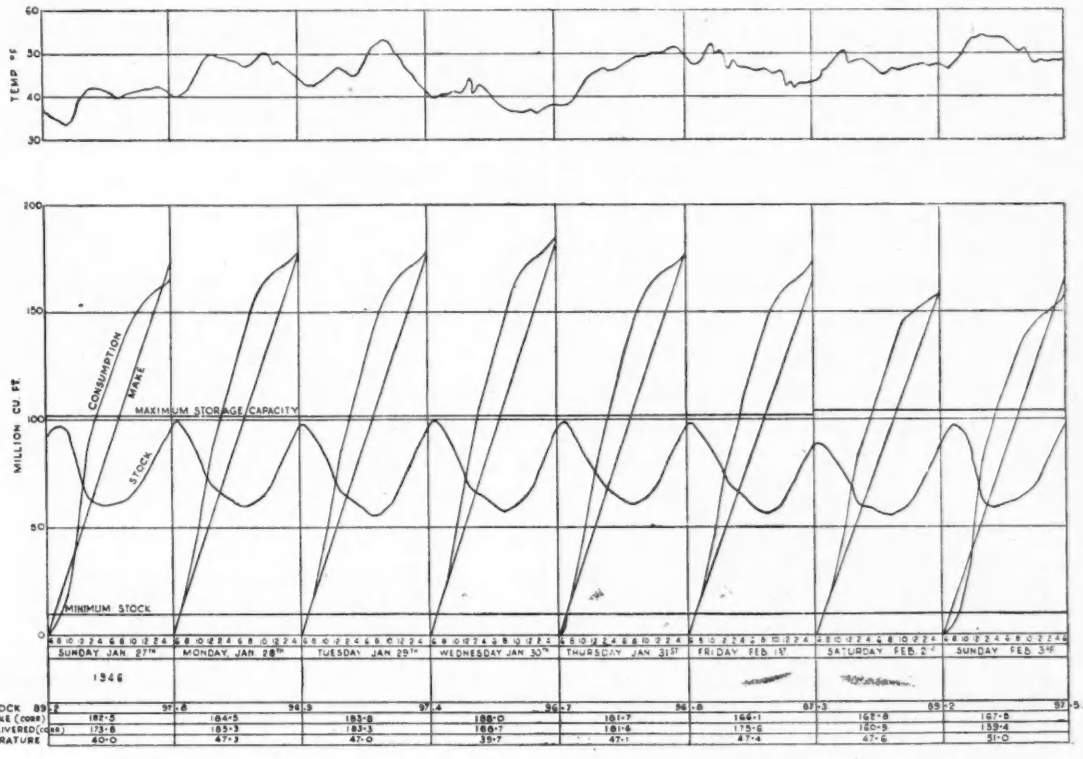


Fig. 3.—Graph showing the daily and weekly cycles in the control of gas stocks.

The 52 weeks are similarly arranged in Fig. 4c, and in Fig. 4d the four quarters are dealt with. Taking this to its logical conclusion we would show annual consumption as a single block, the height of which represents the average hour, day, week, or quarter. Thus we have a family of curves, and the transition from one curve to the next is effected by taking, say, the data of the hourly chart in groups of arrangements of 24 to give the daily chart, the data of the daily chart in groups of seven to give the weekly, and of the weekly chart in groups of 13 to give the quarterly chart. If the scales are suitably adjusted, any one chart can be superimposed on the previous one. Thus the dotted line on the hourly chart (Fig. 4a) is the daily one with its ordinates divided by 24. Comparison of the two curves illustrates the part played by the gasholders and brings out one essential difference between gas and electricity supply. The areas below the two curves are the same.

The quarterly chart is included because this is the only form in which consumer data can as a rule be obtained. It also indicates (if compared with Fig. 4b) how easily one can be misled by the ability of the quarterly total to conceal the magnitude of the daily peak.

It will be noted that this form of presentation includes all the data, but by eliminating the intermediate peaks brings out clearly the frequency of occurrence of any particular range of values, especially at the extremes.

Daily Gas Consumption and Atmospheric Temperature

That some of the variations of daily gas output are closely linked with atmospheric temperature and, no doubt, with other attributes of the weather as well, is axiomatic; and that those who have lived close to the problem have an intimate working knowledge of their nature is the reason why gas stocks have been so well regulated for years past without the use of any detailed analysis, such as that which is the subject of this paper. Experienced valvemen have an uncanny knack of assessing the consumers' needs from day to day, and in the Gas Light and Coke Company a rule of thumb that in winter a change of 1°F. meant a difference of 1 mill. cu.ft. per day in output was for long a good first approximation. It is quite true that within a narrow range of temperature and over a short period of time the relationship is approximately straight line—*i.e.*, a uniform increment in consumption occurs for each degree fall in temperature. But

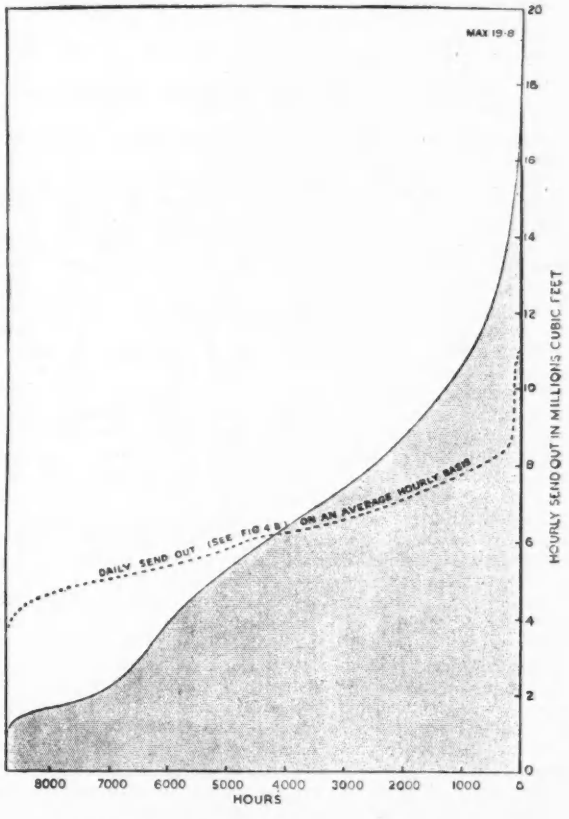


Fig. 4A.—Frequency diagram of hourly send-out.

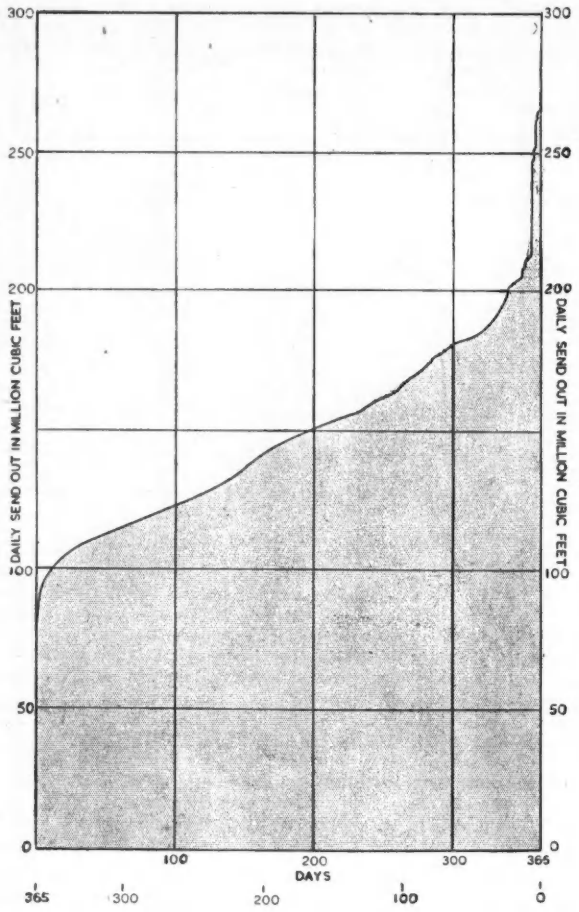


Fig. 4B.—Frequency diagram of daily send-out.

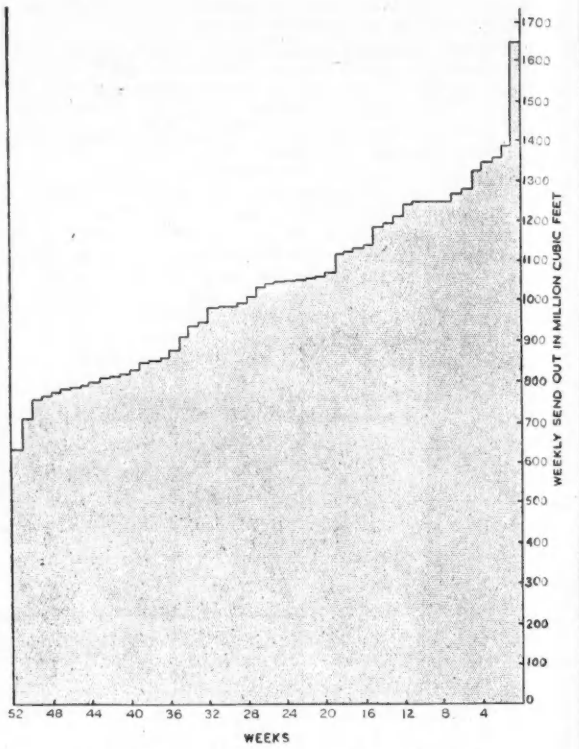


Fig. 4C.—Frequency diagram of weekly send-out.

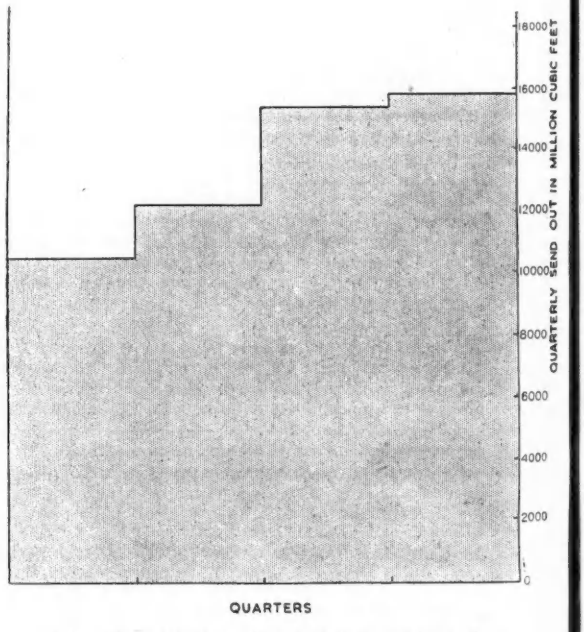


Fig. 4D.—Frequency diagram of quarterly send-out.

we are seeking a general relationship that covers the whole of the temperature range.

Fig. 5a is plotted as a scatter diagram, and in respect of each weekday of 1938 (excepting holidays and other days when special conditions were known to have obtained), the volume of gas sent out and the average temperature. This shows the general trend reasonably well, but the points are scattered in too wide a band to be of great use in forecasting. At a temperature of 55°F., for instance, one would say, reading from the chart, that the consumption should be between 125 and 165 mill. cu.ft., with an average or most likely value of 140 mill. cu.ft. Plus or minus 15 mill. cu.ft. (say, 10%) is too vague.

If a separate chart be used for each month, it will be found that the 20 or so pairs of data show a much better grouping, and it is easy to strike a line of relationship. The temperature range, however, is necessarily limited. Comparing such lines month by month through the year it will be found that they are of different slopes; each is quite good for short-term gas stock control and is really the equation behind such mental process as is commonly applied in that work. Each line is peculiar to the month to which it relates, and should not be extrapolated beyond the temperature range associated with it.

In the case considered, the readings of an external dry-bulb thermometer set up under standard conditions in a Stevenson screen at Fulham, which is approximately the geographical centre of the Company's area of supply, are regarded as typical of conditions in the area. The 24 hourly readings are averaged each day. Dealing with such a large area, location of the thermometer and the representation of temperature are bound to be arbitrary. The best for our purpose are those which provide the closest correlation with gas consumption. In a fruitless search for the ideal many different temperature series were considered and averages over different periods of time were examined, in order to make allowance for the time lag known to occur in certain circumstances. For instance, it may be seen from Fig. 2, and as already mentioned, that a peak consumption of 265 mill. cu.ft. was attained on Wednesday, Dec. 21, which was the day after the lowest temperature, and a reasonably good relationship is found by plotting each day's consumption against the mean temperature for the previous day. The effects of other measurable attributes (sunshine, wind, rain, &c.) were examined, but not deemed worth while to take into account for anything more than minor adjustments in stock control.

Reference has already been made to consumption at 55°F. In London this temperature is typical of the beginning of October

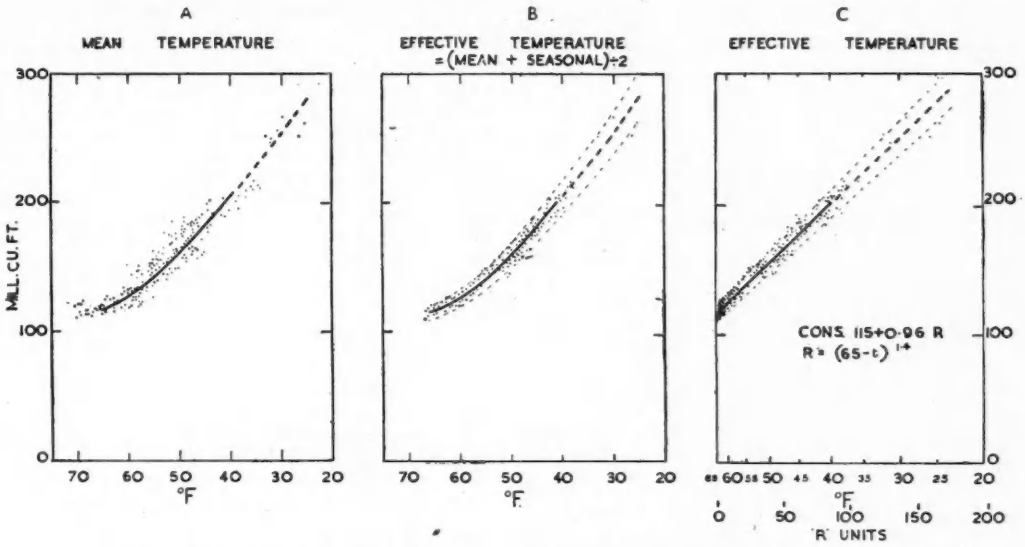


Fig. 5.—Relationship between weekday gas consumption and atmospheric temperature in 1938.

and of mid-May, but can be experience at any other time of year—as a very mild day in mid-winter or as a cold day in mid-summer. But we should not expect it to lead to the same consumption of gas in winter as in summer. Inspection of the data in the neighbourhood of 55°F. confirms that in general the points above the line are those from winter months and those below it from the summer months. Those for May and September/October lie very close to it. This observation led to experimental 'adjustments' in the day's average temperature to allow for departure from the normal. Many alternatives were tried, but it was found that throughout the usual range of temperature (*i.e.*, for anything other than the extreme cold weather) a better guide was provided by taking a figure midway between the 24 hourly average and the expected temperature for the time of year. That is to say, if a temperature of 55°F. were experienced on Nov. 15, for which day the normal is 45°F., then the point for consumption would be plotted against 50°F. Similarly, if 55°F. were experienced in July, when the normal is 65°F., the point for consumption would be plotted against 60°F. This device of the 'effective' temperature has the effect of reducing by more than one half the width of the band of dispersal of the points about the mean line of relationship. With the exception of the four peak days, the same daily consumption data are plotted in Fig. 5b against the 'effective' temperature.

It may be that this effect is partly explainable by time lag, for, if in a very mild spell in January temperatures were to remain at 50° to 55°F. for several days running, no doubt the volume of gas consumed would tend to that expected in October or early May. In the coldest weather the consumer's response is very prompt. Fortunately, or otherwise, we were not given the opportunity in 1938 of observing the effect of such weather on more than four weekdays, and the points representing those occasions lie close to the line without any adjustments.

With the data plotted in this form it is possible easily to draw a line of general relationship through the points, and the same line is found to be a reasonable fit for the more nebulous arrangement in Fig. 5a.

It will be seen that the relationship is by no means uniform over the whole range of temperature variation, although it tends to be so below, say, 50° to 55°F. There is a definite flattening out of the line above these temperatures and, other things being equal, no further fall-off in consumption when the temperature rises above 65°F. This fact is of considerable assistance in stock control during the summer months, for it means that the variations from day to day are much smaller.

It is relevant at this point to refer to the degree-day, a convenient unit for accumulating temperatures and about which much has been heard in recent years. Useful as it may be in other directions, the degree-day method, assuming, as it does, that heating requirements are directly proportional to temperature differences, does not seem appropriate to demand for gas as represented by the total daily output. The author does not presume to be anything more than a layman in these matters, but has long wondered whether the advocates of the degree-day pay sufficient regard to loss by convection, for it was consideration of the convection loss formula which suggested the next step in the analysis of our data. The heat loss from a surface in still air varies as the temperature differences raised to the power 1.25*. The curve for this is similar to the shape of the line in Fig. 5b, but rises less steeply. Using all the available data, curves of this type were fitted by recognised methods. The index so obtained ranged from 1.25 to 1.45, and it was decided

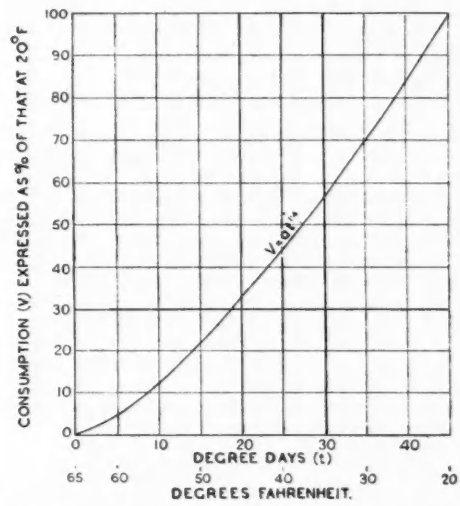


Fig. 6.—Relationship between 'seasonal load' and atmospheric temperature.

to adopt 1.4 as a typical figure. The relationship between temperature expressed in °F., degree-days and the arbitrary units derived from them are shown in Fig. 6. The similarity between the curve in Fig. 6 and the distribution of points in Fig. 5b is obvious. The curve in Fig. 5b can then be represented by the following equation:—

$$\text{Weekday consumption in mill. cu.ft.} = 115 + 0{\cdot}96\ (65-t)^{1{\cdot}4}$$

where t = temperature in °F.

Thus we have a weekday base load of 115 mill. cu.ft., and what we may term the seasonal load, which varies with temperature.

* Dictionary of Applied Physics, I, 474. Technical Data on Fuel, 1947, 182.

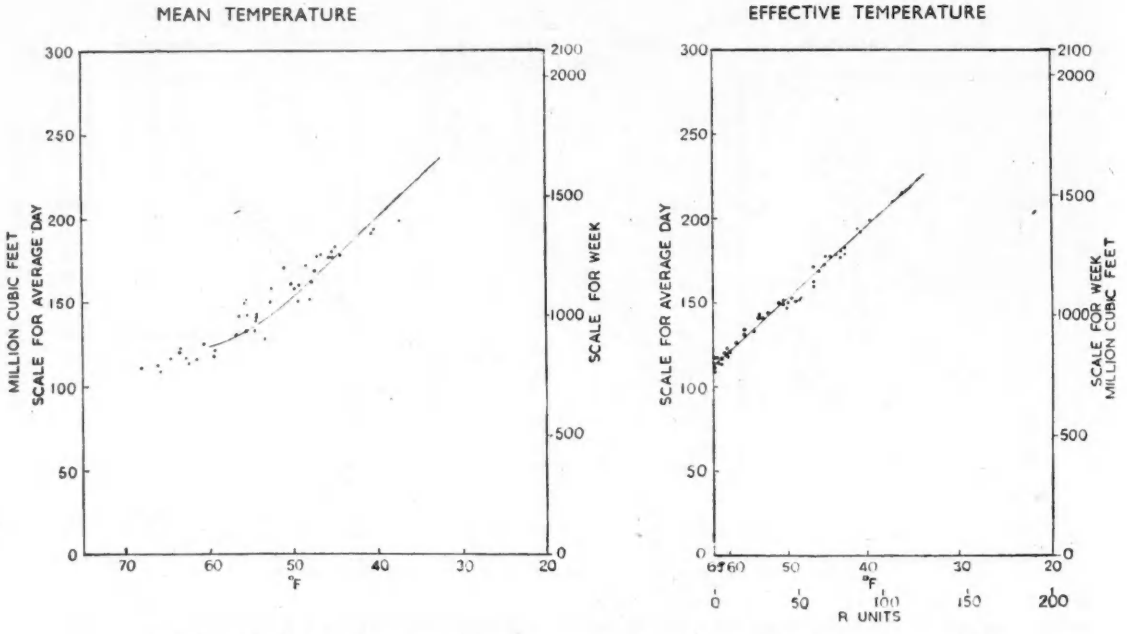


Fig. 7.—Relationship between weekly gas consumption and atmospheric temperature in 1938.

It would be very convenient if it were possible to represent the relationship by an equation of the first degree; in other words, to make use of the simplicity of the straight-line form instead of the curved line drawn in Fig. 5b. Two alternative methods of representing the data in this manner are possible; either the scales can be redrawn as in Fig. 5c, or, what is better for statistical analysis, a new and arbitrary temperature unit adopted, which enables us to represent the equation in the 'straight-line' form. In this way we can re-write the above equation as follows:—

Weekday consumption in mill. cu.ft. $= 115 + 0{\cdot}96\ R$,
where $R = (65 - t)^{1{\cdot}4}$
and t is atmospheric temperature in °F.

It will be appreciated that the same line is a good fit to the data when consumption is plotted against the mean temperature without adjustment; but, as already mentioned, by plotting against the effective temperature the error is reduced by approximately 50%. It will be noted also that extrapolated to temperatures below 30°F. it fits quite well the points representing consumption on the four days of the cold period.

The two dotted lines which run almost parallel with the centre line of relationship represent confidence limits. They are so drawn that in the long run we should expect about 95% of the points to lie within them. Those who are interested in the theory or method of their determination should refer to any standard work on statistical methods, and in particular to the publications of the British Standards Institution dealing with the application of statistical methods to quality control. The problems are analogous.

According to the day-to-day characteristics and the data available, it may not be practicable or desirable to group together the five weekdays, and in this case it is best to deal with weekly data. Figs. 7a and 7b bring out clearly the improved grouping obtained by use of the 'effective' temperature and the high degree of correlation between consumption and effective temperature expressed in the new units. The coefficient of correlation is 0·99.

Temperature Data as an Instrument of Control

Having established a reasonably close underlying relationship between gas consumption and atmospheric temperature, the next stage is a consideration of the nature of the changes in temperature—a very independent variable. A vast amount of meteorological data is available, but the latest developments in weather science still do not give us reliable forecasts for periods of more than a few hours. It is necessary, therefore, that we should be prepared for the consequences of the whole range of temperature

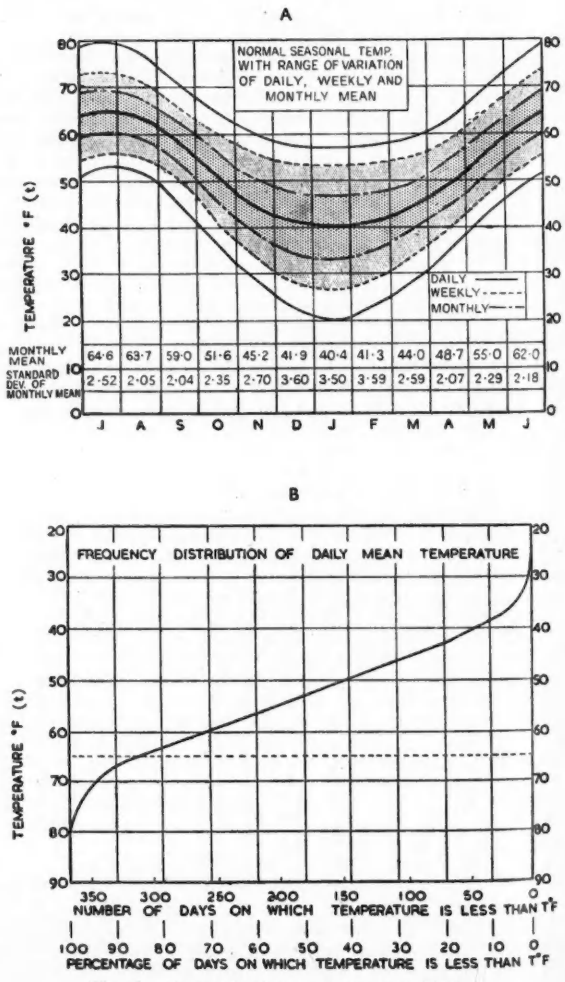

A
NORMAL SEASONAL TEMP. WITH RANGE OF VARIATION OF DAILY, WEEKLY AND MONTHLY MEAN
TEMPERATURE °F (t)
DAILY
WEEKLY
MONTHLY
MONTHLY MEAN
64·6 63·7 59·0 51·6 45·2 41·9 40·4 41·3 44·0 48·7 55·0 62·0
STANDARD DEV. OF MONTHLY MEAN
2·52 2·05 2·04 2·35 2·70 3·60 3·50 3·59 2·59 2·07 2·29 2·18
J A S O N D J F M A M J
B
FREQUENCY DISTRIBUTION OF DAILY MEAN TEMPERATURE
TEMPERATURE °F (t)
NUMBER OF DAYS ON WHICH TEMPERATURE IS LESS THAN T°F
PERCENTAGE OF DAYS ON WHICH TEMPERATURE IS LESS THAN T°F

Fig. 8.—Atmospheric temperature at Fulham.

likely to be expected at any time. The normal or average temhope to do is to know the normal and the likelihood of any given departure from it.

perature is a good guide in that it is an indication of the most probable temperature, but as we must not gamble on the weather something more is required. Unfortunately, the best we can

The Fulham series of temperatures already described cover the period from 1929 onwards, and this has been long enough to include a wide range of weather conditions; they have been analysed and correlated with series covering very much longer periods. Of particular interest is one recorded at Oxford from the year 1815 and published by the Meteorological Office*. This publication gives the normals for each month and the standard deviations. By careful comparison of the Fulham and Oxford series, Fig. 8a was prepared. The heavy centre line in this chart represents the normal or average temperature for any time of year, and the first pair of dotted lines above and below it indicate the range of variation (± twice the standard deviation) likely to be found in the monthly mean—that is to say, the

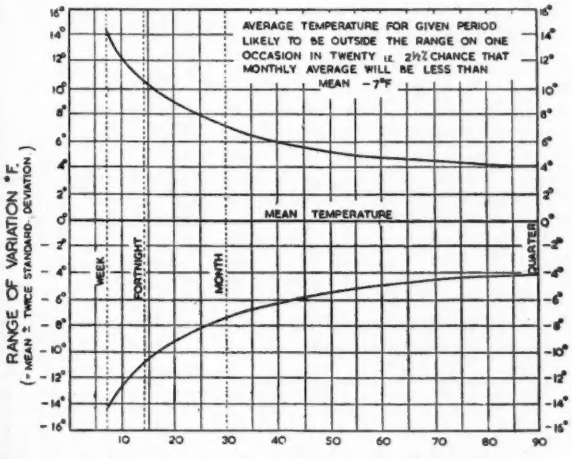

AVERAGE TEMPERATURE FOR GIVEN PERIOD LIKELY TO BE OUTSIDE THE RANGE ON ONE OCCASION IN TWENTY i.e. 2½% CHANCE THAT MONTHLY AVERAGE WILL BE LESS THAN MEAN −7°F
MEAN TEMPERATURE
RANGE OF VARIATION °F. (± MEAN ± TWICE STANDARD DEVIATION)
WEEK
FORTNIGHT
MONTH
QUARTER

Fig. 9.—Variation of average temperature during winter season.

range which in the long run will contain approximately 95% of the data. The next pair of dotted lines similarly define the range likely to be found in the weekly mean temperature. These were based on sampling theory, and inspection has shown the assumption to be a reasonable one. The range of variation in averages taken over any period from seven to 90 days in winter time is shown in Fig. 9. The extreme outside lines in Fig. 8a indicate the probable range in variation in daily mean temperature, but as this is liable to freaks, especially in summer, it is not claimed that it is as accurate as the weekly and monthly limits.

Used in conjunction with the consumption/temperature equation, this chart enables us to predict the normal and the extremes of gas consumption likely to be encountered at any time of the year. It has practical application in the control of gas stocks and the preparation of production schedules; the Gas Light and Coke Company used it continuously from 1940 in predicting gas demand and formulating its policy for programming repairs.

An alternative question is:—'How often are we likely to get a temperature below x°F.?' And here the single-line chart comes in again.

Using the daily mean temperatures collected over many years the number of times each occurred was counted and scaled down to the equivalent number of days per annum. Thus in Fig. 8b we can read off the number of days per annum on which, in the long run, we should expect an average temperature at or below x°F. The rarity with which we experience temperatures below, say, 30°F. in London is conspicuous. These temperature charts can be rescaled in terms of degree-days or the new arbitrary units. The annual totals over the period 1938-48, compared with what may be taken as normal, are as follows:—

		Total 'R'	As % of Normal
Normal Year		15,852	100.0
1938		13,557	85.5
1939		15,073	95.1
1940		17,209	108.6
1941		17,557	110.8
1942		17,415	110.0
1943		13,769	86.9
1944		15,739	99.3
1945		13,637	86.0
1946		15,548	98.1
1947		16,658	105.0
1948		13,508	85.3

* Lewis, L. F., Prof. Notes Met. Office, London 5, No. 77, 1937

Load Factor and Consumption Trends

Fundamental in this work is the method of arriving at an equation which expresses gas consumption in its two main components, the 'seasonal' load, which falls to zero in the summer, and the 'base' load. It is not suggested that the demand for gas for base-load uses is constant throughout the year; indeed, some winter increase is inevitable in an all-the-year-round use, and this aspect of base-load uses is one which deserves more attention.

The proportions in which these two components are combined determine the main load characteristics of an undertaking, and the greater the proportion of 'seasonal' load the more necessary it is to have regard to the influence of temperature variations when considering the trend of business as a whole.

This can be summed up in terms of the separate trends of total demand (as measured by the annual volume of gas sold) and the load factor. For a close study of the market both should be related to standard conditions of temperature. Annual consumption should be adjusted to that which would be expected under normal conditions of temperature, and an expression of load factor, when used in this connection, should be based only on consumption at the minimum temperature likely to be experienced (in London approximately 20°F.), as it is this in the long run which determines installation capacity. Mr. F. M. Birks has shown that on a degree-day basis the load factor of the 'seasonal' load cannot be greater than 31%, the ratio of mean temperature (51°F.=14 degree-days) to a minimum temperature (20°F.=45 degree-days), and that on allowing for the temperature-consumption relationship, as described in this paper, it is reduced to approximately 21%. The difficulty when working with limited data, such as quarterly totals, is to assess the potential maximum

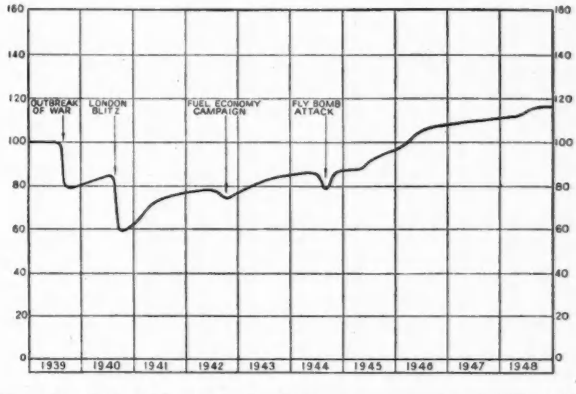


Fig. 10.—Estimated relative level of gas consumption (1938=100) for the Gas Light and Coke Company.

consumption. To overcome this difficulty two empirical formulæ for assessing load factor from quarterly data have been derived.

[These were given in an Appendix to the pages.]

Having determined the consumption equation at any time, the annual consumption under standardised conditions of temperature can be calculated directly, or by selecting the appropriate total of temperature units, comparison can be made with any given year.

It is convenient to use the year 1938 as a basis of comparison, but it will be noted, as has been mentioned in an earlier section, that this was a very mild year as a whole, although in the cold snap of December it did bring extreme conditions for a brief period. It is estimated that the 'seasonal' load that year was only 85.5% of what it would have been given normal weather.

The chart in Fig. 10 describes the relative level of gas consumption for the Gas Light and Coke Company during the past 11 years, using 1938 consumption, adjusted to standard tempera-

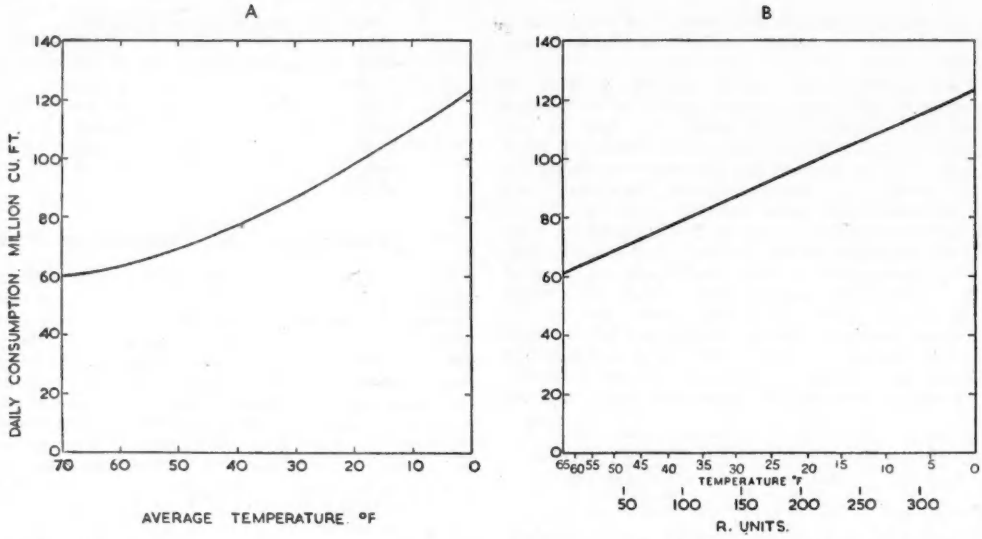


Fig. 11.—Relationship between average temperature and daily gas consumption, Brooklyn Union Gas Company.

ture, as the datum. The effect of the outbreak of war and the incidence of the London 'blitz' stand out, and the response of consumers to the fly-bomb attack in 1944 is clearly shown. The progressive increase in consumption since that time has been under close observation and taken into account in production planning.

Conditions in 1938 and in late 1948 can be compared as follows:—

	Average Daily Consumption Mill. cu. ft.		Total Annual Consumption Standardised Mill. cu. ft.	Index
	Base Load	Seasonal Load		
1938	113	0.89 R	55,540	100
December, 1948...	133	1.01 R	64,630	116.4
Increase (%) ...	18	14	16.4	

It is seen that the relative increase in base load (18%) has been greater than in seasonal load (14%), that is to say, the load factor is better. Before the war the standardised load factor (using equation 2 from the Appendix) was 52%; at the end of 1948 it was approximately 55%. It was at its best during the war years. By 1941, although total demand was still more than 20% below pre-war, the proportion of base load had so increased that the load factor calculated in this way was up to 61%.

One object of the Paper has been to emphasise the importance to be attached to load factor as a characteristic of consumer demand and to outline a method of load analysis. Detailed consideration of the incidence of load factor on the cost of production of gas, including its bearing on the selection of plant and determination of optimum storage capacity is not within its scope.

It has described what is felt to be the underlying relationship between gas consumption and atmospheric temperature in the London area. Since the methods and formulæ are empirical, many variations are possible and there may well be some which will be found as good or better than what has been evolved. How far it is worth seeking further precision in results may be questioned. For instance, it may appear that accuracy in correlation of output and temperature as an instrument of production control is defeated by unreliability of weather forecasts. It is unfortunate but true that the period over which weather science can predict with any degree of certainty is still measured in hours. So far from detracting from the value of the work this, in the author's opinion, goes far to justify it, for the method indicates not only the most probable consumption at any time, but the safe minimum reserve of plant and stock required to cover the worst eventuality as regards the weather. It facilitates the planning of the major repairs programme, and by centralised stock control the smaller jobs can be fitted in before they become urgent, thus minimising the risk of interruption by breakdown.

It is not presumed that the same relationship necessarily holds good in other parts, and special caution is necessary before applying any of the results to small groups. Yet, as the Gas Light and Coke Company covered such a wide area, it may be worth testing elsewhere. No further claim is made, but so far as it has been possible to judge from the limited data available, the broad results are of wider application. Especially encouraging was a small graph which appeared some time ago in the *Brooklyn Union Gas News*. As will be seen from the final chart, Fig. 11, the arbitrary temperature units fit the Brooklyn curve almost exactly, not only over the range of 65° to 20°, but down to 0°F. Fig. 11a shows the original curve; in Fig. 11b the same curve is replotted on the special scale.

DISCUSSION

Mr. J. E. Davis (South Eastern Gas Board) said he was sure that Mr. Rose would forgive his commencing his remarks by a criticism. It was not a criticism of the paper, because there was so much on every page of the paper with which he was in agreement; but he wished to criticise the title, which recalled all too depressingly other economic surveys with their gloomy forecasts of the unattainable, yet Mr. Rose had every reason to be gratified by his most successful effort to find some law and order in gas demands and even in the British weather. So thoroughly had that been done that his own remarks might well appear superfluous, and certainly they must lack the mathematical skill of the expert statistician. Nevertheless, it might not be without interest if he explained how the same problem of forecasting and of providing for gas demands had been approached in a slightly different way, with conclusions on the whole parallel with those which Mr. Rose had described. The data examined were the gas demands in the South Metropolitan district in the ten years 1929-38, which included two very cold spells, one of them the exceedingly sudden cold spell of December, 1938, to which Mr. Rose had referred.

Part Played by Holders

The first matter to be investigated was the part played by gasholders. It was well recognised, of course, that holder storage smoothed out the variation in demand from hour to hour and to some extent from day to day; the question was how much of the available holder capacity must be reserved to meet this hour-to-hour variation. It was convenient to express the total available holder storage in hours capacity, the 'hour' being one twenty-fourth of the maximum day.

The normal picture, as Mr. Rose had shown, was that from 6 a.m. the output of gas exceeded the rate of manufacture, and stock continued to be lost until some time in the evening. Over the ten years examined, the heaviest loss of stock on any day—or, putting it another way, the greatest cumulative deficit of make in relation to demand—was equivalent to seven hours' storage. On most days it was between five and six hours, a result which was in agreement with Fig. 3 of the paper. The balance of available storage could be employed to smooth out the variation from day to day. The assumption was then made that over these ten years there had been in operation an accurate but unintelligent machine producing each day a quantity of gas equal to the average amount sent out over the preceding seven days. Such an unreasoning machine would have needed ten hours' storage to compensate for its inability to judge from weather fore-

casts and other knowledge the probable daily demand. A man, of course, should be able to do better than that.,

The seven-day moving average of gas outputs was then used for another purpose, namely, to obtain a statistical norm curve for the 365 days in the year and to compute the probability of departure from the norm over any one period of seven days. This norm curve had a distinct resemblance to Fig. 8 in the paper, but the curve represented gas outputs, not temperatures. The curve was drawn to a scale where 100 represented the mean daily output for the year. If any point on the centre line was taken, the reading showed the most probable value of the gas demand for that seven-day period in relation to the mean for the year. It also showed the probability of the actual demand being above or below the most likely figure. The first thin line on either side of the centre line represented the 1 in 50 chance, and the outermost thin lines showed the 1 in 1,000 chance. The 1 in 1,000 chance had a wide separation from the most probable figure during the critical winter period from mid-December to mid-February. That represented the amount of gas which the works must be prepared to supply, though only for about one week in 20 years would it actually have to meet that demand.

The reason for preparing a chart in such a form was the recognition that the gas output was predictable only within limits, and that to the engineer who had to meet the situation day by day a statistical mean was not always very helpful. Perhaps he could illustrate the point by reference to two other figures. One was a scatter diagram relating gas output to temperature for that most difficult period, the winter period of the year. Each one of the points represented an actual day, the precise circumstances of which had to be met there and then. The other showed the statistical relationship between gas output and departure from the normal temperature, and he agreed with Mr. Rose that it was not linear; it was to the power of 1.4 or thereabouts. That statistical relationship was a very useful guide to what was most likely to happen, but very few actual days would fall right on that line.

Value of Weather Forecasts

There was another unfortunate difficulty in using statistical relationships for the single case. Statistical relationships could be derived only from past facts, whereas the gas engineer had to produce gas to meet a demand which had not yet materialised, and he had to use a weather forecast based on the best data available, but still a forecast which the event might falsify.

Speaking generally, he would like to say in passing that the forecasts of the Meteorological Office proved most helpful, but it would be of great advantage if during the period of the year when severe cold spells were liable to occur there could be given what he might call a second choice—not necessarily a forecast, but a warning that a mass of cold air was building up over Scandinavia and might come towards this country, or, during a cold spell, that while the forecast expected warm air from the Atlantic to come here and produce a thaw, there was a risk that it might turn tail and the cold air come back. He realised that the Meteorological Office would hesitate to commit themselves to a second choice, but such knowledge at the back of one's mind would often be very useful.

Returning to the first curve which he had shown on the screen, he would like to explain a few of the many ways in which this had been of great assistance to the South Metropolitan Company in the post-war period. First, he would deal with the trend of demand. He had explained that the curve was drawn to a scale where 100 equalled the mean day for the year. By taking the actual demand experienced and relating it to the value on the chart, an actual value could be given to the mean daily output, or, as they called it, the M figure. This M figure was calculated week by week, and an accumulated average to date maintained. From its movement it was possible to deduce the trend of demand free from the influence of seasonal variations. This proved of tremendous assistance in 1945 and 1946, when, with population returning to London, figures of daily increases over the previous year lost all meaning.

Formulation of Production Programme

The second use was the formulation for a year ahead of a production programme for the undertaking and for individual works. The curve showed the most likely amount of gas required week by week through the year, and also the amount which one must be prepared to make at any period. Taking the N figure for the previous year, with certain modifications in view of the trend, and bearing in mind such factors as new housing or extension of industrial uses, a forecast curve for the following year was drawn. This was then broken down into a programme of plant available and probable gas production for each works. From it there could be prepared an estimate of wages expenditure week by week, coal consumed, and the production of coke and other products. The chief accountant could use these figures as a basis for his budget; the repairs programme was adjusted to accord with the gas demand programme; the coke manager knew where and when coke was likely to be produced, and the products manager had a picture of tar and benzole production. The system had proved of undoubted value in all those departments.

A third and still more revolutionary change in South London had come about from a study of this curve. Gas manufacturing plant now being installed at East Greenwich would, together with existing plant, comprise coke ovens, horizontal retorts and water gas plant. In laying out this assembly it was intended that the coke oven plant should take base load, and that horizontal retorts should take the seasonal coal gas load. The coal gas from these two types of carbonising plant, plus sufficient blue water gas to dilute to 500 B.Th.U. per cu.ft., would be programmed to give the most probable demand at each period of the year—*i.e.*, to follow the centre line. If unpredictable variations brought the demand below, a 10% reduction in make could be obtained by diluting with producer gas instead of blue water gas, and it was intended that producer gas should be made in the water gas plant. Similarly, if unpredictable variations sent the demand above the most probable value, coal gas would be diluted to 500 B.Th.U. with blue water gas, and carburetted water-gas at 500 B.Th.U. would be used to make up the deficiency. In actual practice, of course, the whole of the water-gas would be carburetted to a calorific value less than 500 B.Th.U. per cu.ft.

Finally, he exhibited a slide which showed the weekly control board which was used to adjust daily makes to meet variations in demand. This board had a number of coloured movable pegs, and those shown in the diagram as bars represented the stock of gas at 6 a.m. The area at the bottom of the chart below an arrow 'Minimum stock' represented that amount of gas which must be held to meet the cumulative deficit of make during the day, *i.e.*, seven hours' storage. The space between minimum and maximum represented the storage capacity available to take up day-to-day variations over the week. From the norm curve it was known what was the most probable average daily demand for that week, but this had to be modified according to the weather forecast, bearing in mind the statistical relationship between temperature and demand. Having regard also to the characteristic shape of the weekly output curve, which in South London meant a high demand on Mondays and Sundays, and a falling off on Friday, and still more on Saturday, pegs were put against each day to show the forecast output. The make was then adjusted so that the holder stock would fall progressively during the week and recovery by 6 a.m. on Sunday; but, of course, on Tuesday morning the weather and the public might not have behaved as the statistical average would suggest, and the pegs might have to be moved to give a closer approximation in the light of Monday's experience.

This method worked well, and had permitted fluctuations in demand, as well as increasing demand in the last few years, to be met with confidence, notwithstanding the relative inflexibility of production when operating with horizontal retorts alone. Judgment must still be exercised, but it was judgment within limits and with statistical data as a guide.

Three District Cycles

Mr. **B. G. H. Clegg** (Statistician, North Western Gas Board. Liverpool Undertaking) said that it was perhaps natural, on examining such a paper as that by Mr. Rose, to compare the methods and conclusions with those of one's own undertaking. In the present case, the similarity in approach, but difference in methods evolved, at Liverpool might make such a comparison of interest, at any rate to those engaged in similar analyses.

Like Mr. Rose, they had found it essential to regard gas delivery as dependent on three distinct cycles and to establish a curve of normal temperature. Their experience confirmed Mr. Rose's conclusions on many points, including the lag in consumer reaction to rises in temperature, and the limitations of the weather forecasting service and of degree day methods. They were indebted to Mr. Rose for the daily control chart used in their distribution control room. On it the forecast of cumulative delivery was recorded and, in conjunction with the automatic display of holder stocks and pressures, they could confirm that it proved most effective; so that it was mainly in detail and in emphasis that their methods differed from those outlined in the paper.

A fairly good correlation between total delivery and atmospheric temperature could be established by using any reasonable temperature index and by examining the daily deliveries over either monthly or quarterly periods. As a first step towards obtaining a correlation close enough for their requirements, daily correction factors were applied. A variation unconnected with temperature but due to known delivery characteristics of particular days of the week was thus eliminated. An essentially different method of correlation was then applied to the resulting corrected delivery figures.

For each month the delivery was related to two variables simultaneously—temperature and time. This method, consisting essen-

tially of fitting a plane to a set of points in three dimensions, produced partial coefficients of correlation between delivery and temperature, and between delivery and time. The temperature coefficient measured the amount by which delivery tended to change with unit change of temperature at a given date. The time progression factor measured the extent to which delivery tended to change each day if the temperature remained constant. The correlation between delivery and time was sufficiently high to be significant and the time progression factor was positive from September to December and negative from February to May. By its use, the fact that the same temperature at different times of the year gave rise to different deliveries could be interpreted mathematically. They had not then found it necessary to resort to arbitrary temperature indices, and he would suggest that this was a considerable advantage. Though he agreed with Mr. Rose that degree-day methods were unsuited to delivery analysis, he did not find immediately acceptable a logical connection between the total delivery of a large undertaking and the convection losses from a surface in still air.

It was interesting to note that Mr. Rose had found it possible by extrapolation to extend the delivery/temperature correlation to cover days when average temperatures fell below 30°F. It was their experience that in very cold weather the linear relation broke down and there was a discreet jump in delivery, probably associated with the thorough chilling of the fabric of houses and the freezing of water pipes.

An Ideal Basis for Estimation

Turning to the single line chart, which was put forward as of wide application in load analysis, perhaps after further study or in the discussion of the paper its uses might become apparent. On first inspection, however, agreeing as he did with Mr. Rose that delivery was dependent on three distinct cycles, to present the total variation in a single line chart seemed to him to conceal rather than to illustrate its true nature. On the other hand, the 2-sigma presentation of the temperature charts (Figs. 8 and 9) gave an ideal basis for estimation of the probable extent of variation from forecast deliveries, and he would like to congratulate Mr. Rose on a most admirable treatment of the probability of departure from normal temperatures.

Their own analysis had been based mainly on delivery figures since 1943, and it was perhaps for this reason that their approach had differed in emphasis from that of Mr. Rose. Since that time sales had increased by over 7% per year for reasons quite unconnected with temperature. While it had been essential for proper production planning and financial control to have a full knowledge of seasonal variation in delivery, analysis of the variation due to other factors had been of at least equal importance. They had been led, therefore, to examine the extent to which delivery had been affected by, for instance, the domestic coal position, a very considerable factor in the North. The orders for large industrial gas installations and, this year, the reaction of consumers to their first quarter's electricity bill, were examples of factors with a considerable and to some extent predictable effect on gas deliveries. Sales analysis, involving the isolation and separate examination of different blocks and classes of consumption, had deserved at least as much attention as the rather more mathematical analysis of seasonal variation in delivery.

Quarterly Sales

Under constantly changing conditions, it had not been found practicable to apply any formula for load factor to quarterly sales. If, for example, the seasonal load factor formula given, but not very clearly defined, in the appendix to the paper were applied to their figures for industrial sales in 1946 and 1947, the results would be 9% and 6% respectively. The difficulty of deducing anything from this reduction became clear when the figure for a twelve-month period from mid-1946 to mid-1947 was found to be 13%. The limitation of such methods was implied in the rider that before their use the effect of other influences must first be eliminated. However the figures were treated, one could never be sure that this had been done, and to extend the use of factors and indices too far was perhaps to invite what Benjamin Franklin called 'One of the tragedies of life—the murder of a beautiful theory by a gang of brutal facts.'

Reflecting People's Habits

Mr. J. H. Dyde (Deputy Chairman, Eastern Gas Board) said that those with a flair for figures would find the paper fascinating, but whatever people's reaction to statistical interpretation might be they would be bound to admit that Mr. Rose had presented an extraordinarily well-written paper, leading logically from one phase to another as the theme was developed. In expressing the ever-changing rate of gas consumption as reflecting the habits of the people and the way in which they adapted themselves to seasonal changes, the author said 'It is a curious combination of the solar and the secular.' That sentence was a gem, for it combined the alliterative art of an Alexander Pope with some of the epigrammatic genius of an Oscar Wilde.

It was true to say that the gas engineer of the single, small, medium, or even large works of pre-war days worried little about the vagaries of the weather, the day-to-day and month-to-month changes in his demand. There were always a few extra retorts available, another shift of water gas to put on, and his generally adequate holder capacity to cushion the unexpected changes. It was the exceptional winter, occurring with indeterminate frequency, that set the standard for his plant capacities. The war, however, cut down that adequate reserve of plant and accentuated the seasonal load by a very definite change in habit of the people. It was those conditions that made really apparent the importance of load factor and its effects on the control of plant operation.

Economic Effect of Forecasting

The economic effect of forecasting load became of increasing importance with the present trend of development into larger plant units and physically linked production stations. It was understandable, therefore, that the former Gas Light and Coke Company, representing the largest combined system of gas production units in the world, should have given close and scientific study to the problem of load variation with temperature. Mr. Rose had given a method which would be invaluable to those who sought to progress on similar lines, and the technical interpretation of his results was carried a considerable stage further in the paper to be presented by Mr. F. M. Birks at the International Gas Conference the following day. The two papers should, in fact, be read in sequence.

The only large undertaking in the Eastern Area with a number of linked works and a centralised control, from which he could obtain any data, was the former Tottenham and District Gas Company. He hoped that time would permit Mr. Hawes, who was in charge of that centre, to add a few remarks.

Personally, in the brief time since he first saw the present paper he had had charted single-line curves similar to Fig. 4(b) of the paper, showing the frequency diagram of daily send-out for 1938 of several former companies of varying size and of different community interest.

The first chart gave the comparison between the daily frequency of output of the former Tottenham undertaking and the Greater London area of the former Gas Light and Coke Company as given by Mr. Rose. The charts had been reduced to a common basis by expressing output as a percentage of the mean daily figure. It would be seen that the Tottenham curve was very much flatter, with nothing like the same relative peak at the one extremity or the same depression at the other.

Problems of the Seaside Resorts

The second chart showed the corresponding curves for three small provincial communities, two of them (Huntingdon and Maldon) rural in character, and the other (Cromer) a seaside resort, all sending out in total about the same quantity of gas per annum. As would be expected, the seaside resort showed a curve with different characteristics, due to the effect of the seasonal holiday load. Taking the other two, however, it would be found that there was not a very great deal of similarity between them, but they tended to approach more nearly the characteristics of the Tottenham curve rather than of the curve relating to the Gas Light and Coke Company.

He had shown those charts to make the point that he could not believe that the same consumer habit could apply to small provincial and rural communities as to a central and suburban population. He could not believe that the empirical formula given by Mr. Rose would fit such diverse conditions. The author was careful on this point in his statement that, while the formula would appear to have wide application—and it had been shown that morning that apparently it applied very closely in the case of the former South Metropolitan Gas Company, but did not necessarily apply in Liverpool, judging by the remarks of the last speaker—it might not necessarily provide the right answer. It was very intriguing mathematically to reduce everything to a straight line, but as a sceptic he did not think that life or gas output was as simple as that. It might be that a more correct interpretation in most cases of the scatter diagram relating output with temperature was a series of straight lines, with a line for each month of the year and each day of the week.

The Quest for Straight Lines

Mr. Rose did deal with that point in Section V of his paper, where he said that if a separate chart was used for each month, comparing such lines month by month through the year it would be found that they were of different slopes; but what did that matter? If one had a chart representing April and a chart representing September, and had a typical day for each of those months, one could obtain just as close a consideration for control purposes as one would have by trying to reduce everything to a straight line.

He would await with interest a great deal of statistical information which he knew would be forthcoming and which would be

encouraged by the paper, and the interpretation of that information would be of very considerable interest.

Mr. F. O. Hawes (Tottenham) said that any remarks which he made were not in any sense a disparagement of what was a magnificent paper, which was a further example of the fine work carried out by the great organisation which Mr. Rose represented. There was, however, an old proverb which said that there was more than one way of killing a cat; while another, perhaps more apt to the present occasion, stated that circumstances altered cases. Mr. Rose had himself drawn attention to this in his concluding section.

The Gas Light and Coke Company was unique—unique in size, and unique in the concentration of its load. For example, the inner area of the former Tottenham Company was about one-third of the whole area of the Gas Light and Coke Company, but consumed less than one-tenth the amount of gas consumed in the area of the Gas Light and Coke Company. It was necessary, therefore, to be cautious in applying results derived in the intense urban concentration of London to other and more dispersed areas. He thought that the agreement found with the Brooklyn figures and with the South Metropolitan figures illustrated the point which he was making; there was similarity there because the circumstances were similar.

Mathematical Equation

At Tottenham they had studied this matter of output in relation to temperature. In the first place, they hoped to arrive at a method of estimating daily requirements for some 24 hours ahead with a greater precision than the valve man's rule-of-thumb method. He was delighted to read that these men unconsciously applied a mathematical equation to their estimates, and he thought that this must have something to do with the raising of the school-leaving age. In the second place, they aimed at being able to make some reasonable forecast of future requirements.

As a result of their studies, they decided that a linear relationship existed between temperature and output over short periods of about a month, as Mr. Rose had intimated. They agreed with Mr. Rose that such lines were peculiar to each month, and that each had a different datum. They thought that this was eminently reasonable. There were seasonal effects other than temperature which made the basic output wax and wane through the year. The hours of daylight, the amount of hot food cooked, the time spent indoors and many other factors made it obvious that a day in January would require a greater output than a day of similar temperature in September; and such days did occur.

They therefore based their system on this changing datum and changing slope of line. For each month the output, if the temperature remained at 60°F., would be so and so—a different figure for each month. For each degree drop in temperature there was an increment of output which again differed slightly for each month. They called the datum for each month the basic figure, and for the last two or three years it had so happened that the slope was reasonably proportional to that basic figure, and in fact had been very close indeed to 1% of the monthly basic figure for each degree. It would be realised that this greatly simplified all computations.

The Degree Day

They did not feel what the expectation of a power law for the relation between temperature and output could be justifiably based upon the well known equation for heat transfer by convection in still air. Still air conditions very rarely existed outside buildings, and, with moving currents of air, the heat transfer from within the building was more likely to be in linear relationship with the temperature difference, and a great deal of the heat loss was due to ventilation. They had used the much despised degree-day, not based on 65°F., but the London and Counties Coke Association degree-day, which was based on a temperature of 60°F., and which took special account of days on which the maximum temperature was above 60°F. It was their impression that when the minimum for the day did not fall below 60°F., the quantity of gas used for heating was negligible. These simple degree-days plotted against outputs gave very good lines month by month, and those lines could be extrapolated outside the normal range of temperature for the month, and fitted in very well with the actual outputs on the occasional days of abnormal temperature.

If the curves for each month were put on a chart, it would be found that, for example, September, October and November each started with a different datum and each increased slightly in slope. The dots for September would cluster round the bottom of the line; for October they would be further along, and for November they would be further along still. It was possible to put a single straight line through those dots which was a reasonably good fit, and a statistical calculation would give a good correlation, but the scatter was very much greater than if one calculated the coefficients and the scatter for individual monthly lines, and therefore, as Mr. Dyde had indicated, they felt on much sounder ground in using a separate figure for each month. It also enabled them to keep a close watch on the trend of output.

Using their determined temperature coefficient, they corrected each month's output and obtained the actual basic output for the month, *i.e.*, the output which they would have expected had the temperature remained at 60° F. throughout. If they compared the basic figures for the month of January of this year and last year, they could see what the true percentage of increase in output was, independent of weather, and by plotting month by month the increase of each month over the corresponding month of the previous year they could get a true idea of what was happening and a trend line to follow to take into account in formulating further estimates. Incidentally, they had related that trend since the end of the war very closely indeed to rate of growth of population as people had come back into the area, and, now that that was stopping, their line was very nearly horizontal. Due allowance had of course to be made for public holidays in assessing those figures. Coming back for one moment to the ordinary day-to-day forecast of output for plant programming, the differences between Mondays and Sundays and Saturdays had to be taken into account.

Mr. Rose said that he found that corrections for wind, sunshine and so on were not worth while. When considering period figures, that was true, because they tended to cancel out over periods of a fortnight or so, but it was not by any means true if one were going to consider the probable maximum output, because it was the experience in our climate that on days with a temperature of 20° F. or so there was also a bitter east wind, and perhaps frozen snow lying on the ground. In fact, in the cold spell of two or three years ago, those factors increased the degree-day figure by some five to seven degrees.

Changing Habits

In general they had not bothered a great deal about the summer figures, because the spread of holidays since the war and changing habits made the summer figures somewhat erratic. That was one reason why they were working on post-war figures, rather than basing their calculations on the 1938 figures; the change in the area was too great to rely on the earlier figures.

They were very appreciative of Mr. Rose's analyses of the expectation of temperature as shown in Fig. 8, and would find them of great use. They were, however, basing future plant requirements on the expectation of periods with temperatures at 20° F., and they noted that that figure was also adopted in the paper. They took their figures from a most important paper by Mr. Grierson, of the former Northmet Company. Mr. Grierson had made a very interesting hundred-year analysis of temperature.

The **President** said that no doubt Mr. Rose would wish to make a comprehensive and considered reply to the discussion. Moreover, the time available for the morning session had elapsed, so that it would be necessary for both reasons for the reply to be made in writing.

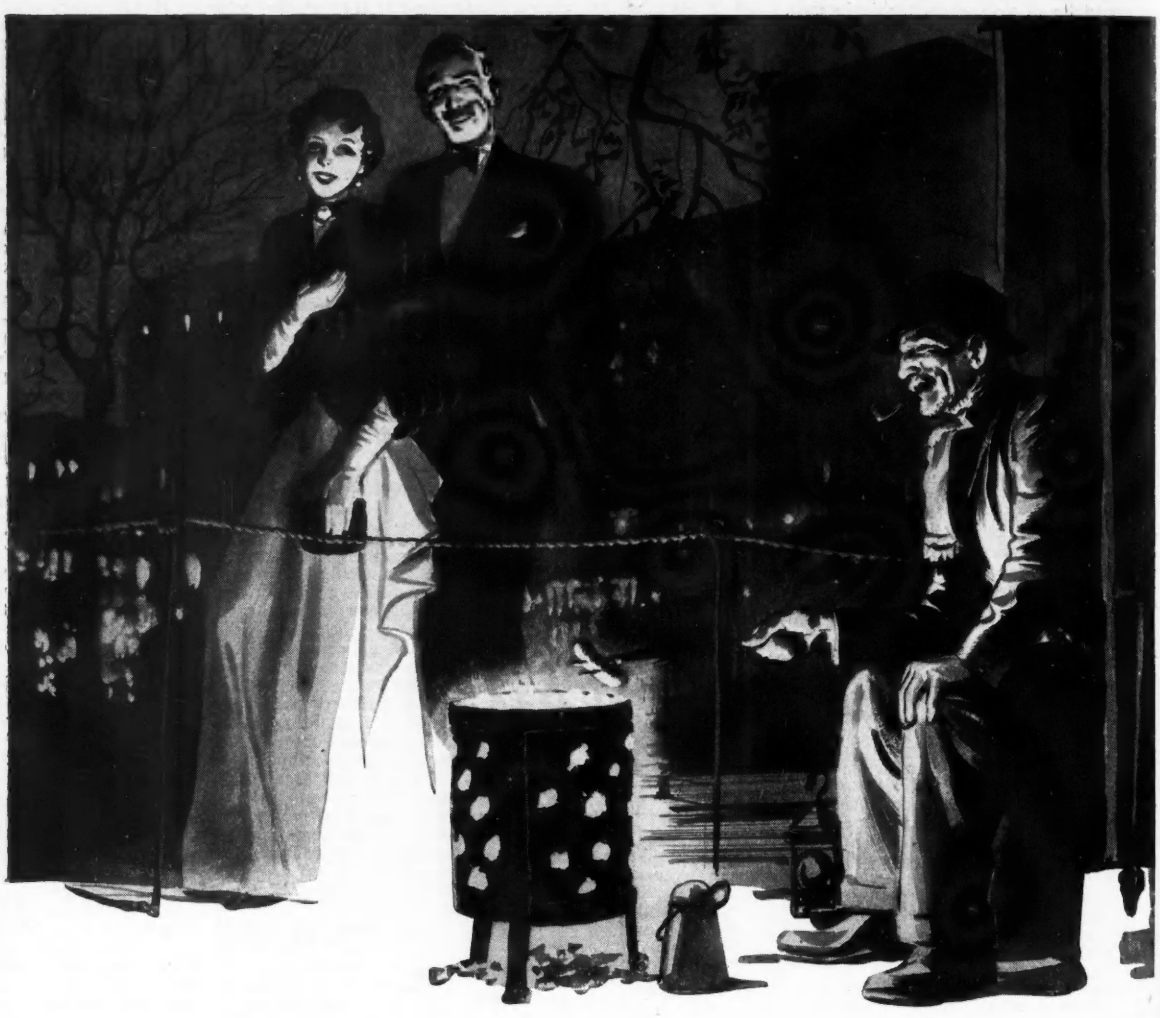
RECEPTION AND DANCE

The main social occasion of the Institution was held at the Connaught Rooms on Tuesday. The President and Mrs. Crowther received the guests. Approximately 750 attended and the evening was a great success. The arrangements were of the highest order. The bouquets were presented by Mrs. H. Forrest and the prizes were presented by Mrs. E. Crowther. Bill Sewell and his Band provided the music. The S.B.G.I. golf prizes were presented during the evening. The Coronation Plate was won by Dr. W. Davidson with a net score of 71 after a tie with Mr. L. F. King. The Thornton Cup was won by Mr. P. D. M. Aird, of R. and A. Main, Ltd., with a score of 71, after a tie with Mr. B. C. Morton, of R. Dempster and Sons, Ltd. The best score was that of Mr. J. S. Smith, of the Ministry of Fuel and Power, who returned a net score of 69.

EVENING STAR LODGE

A warm welcome was extended to Colonel C. M. Croft, President of the International Gas Union, Mr. C. H. Chester, President-Elect of the Institution of Gas Engineers, and a large number of visiting brethren at the meeting of the Evening Star Lodge, which was held, as usual, on the Monday in Institution Week. The meeting was held at the Café Royal, Mr. W. S. Gooch, M.C., Worshipful Master, presiding, and there was a total attendance of about 250. Mr. F. B. Crow, W.M. of the Northern Star Lodge, and Mr. W. L. S. Spinks, W.M. of the Murdoch Lodge, took part in the Lodge proceedings, and at the close of the agenda the W.M. in the name of the Lodge expressed pleasure at the attendance of so many visiting brethren in connection with the 86th Annual Meeting of the Institution of Gas Engineers and the Fourth International Gas Conference.

Later in the evening Mr. S. E. Whitehead, Deputy Chairman of the Southern Gas Board, responded to the toast of the Officers of London, Provincial, and District Grand Rank, proposed by Mr. H. J. Randall, and Colonel C. M. Croft, Mr. C. H. Chester, Mr. F. B. Crow, and Mr. W. L. S. Spinks replied for the visiting brethren, whose health was proposed by Sir Frederick West.



". . very interesting—but give ME the

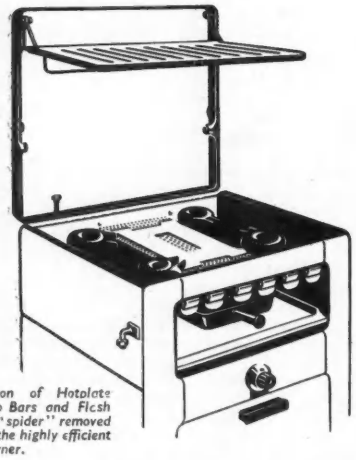


Illustration of Hotalate with Top Bars and Flesh Ignition "spider" removed to show the highly efficient Grill Burner.

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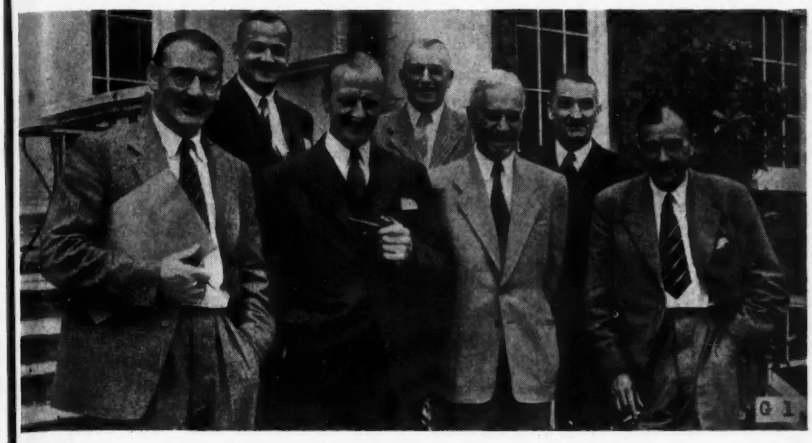
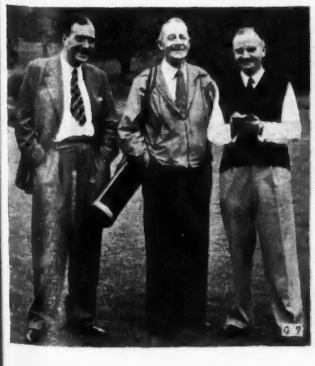


Left to right: W. Morland Fox, Francis Drake, H. S. Cheetham, C. R. Averill, H. G. Williamson, F. B. Holmes, W. R. Edgar.

"S.B.G.I." AND "I.G.E." AT GOLF

THE compressed timetable for Institution Week was in no way allowed, by the energetic Committee of the S.B.G.I. Golfing Society, to interfere with the excellent arrangements the Society make from year to year to entertain the Industry, at large, to golf. This year the competitions took place on the Monday morning at the Sudbrook Park Course of the Richmond Golf Club, and the weather was brilliantly fine. Forty-two cards were taken out, and many more than that number were at lunch. The Society were honoured by the presence of Mr. C. H. Chester, Vice-President of the Institution of Gas Engineers and Chairman of the South Western Gas Board; also Mr. G. E. Currier, Deputy Chairman of the North Eastern Gas Board; Col. C. M. Croft, President of the International Gas Union; Mr. H. S. Cheetham, Managing Director of Humphreys and Glasgow, Ltd., and in his official capacity as past Chairman of the S.B.G.I.; and Mr. M. W. Burt, Manager and Secretary of the Society. For the prize winners, see our report of the evening reception.

Above: A portrait of Brig. C. A. H. Fairbank; in the group are M. H. Thornton, J. S. Wood, Chas. Cooper, J. C. Woodall.
Below: W. R. Edgar, C. E. Holt, W. Lowe. C. R. Averill, S. C. Thomson.



Four pictures on the right show L. F. King and Walter Scott; J. C. Clay and D. J. Colvin; C. H. Chester and W. H. G. Roach; J. W. Broad and Darrell W. Rees.

SYMPOSIUM OF SHORT PAPERS

At the afternoon session of the Annual Meeting of the Institution of Gas Engineers, on June 14, the President said that, in inviting members to submit short papers on a wide range of subjects, the Council had embarked on an experiment which he thought the members, after hearing the papers, would agree had amply justified itself. He trusted that the members would find the papers as interesting as he had found them. While time would not permit of their discussion at the present meeting, it might be that the Districts would find a profitable occupation for one of their sessions in such a discussion.

UNIFIED CONTROL OF MANUFACTURE IN A MULTI-WORKS UNDERTAKING

By H. Moys, B.Sc.(Eng.), A.M.I.C.E., Deputy Gas Engineer, Liverpool

OUR undertaking much appreciates the opportunity of contributing to the papers comprising the symposium, and Mr. Brown and I in presenting these short papers hope that what we have selected to describe will be of interest to members.

For many years the four works of the Liverpool undertaking have been interconnected by a messenger main system, and also by an intermediate-pressure distribution main linking the two main works and running on the perimeter of the district.

The various works, situated 12 miles apart, have daily outputs of 20, 19, 7½ and 3 mill. cu.ft. They serve an area of about 100 sq. miles and supply 250,000 consumers.

Prior to 1943 the four works used to operate, and were almost managed, as separate company units, the surplus gas being passed between the works by agreement of the managers. It was then realised that by introducing a more unified system of control large economies and advantages were possible. These are summarised as follows:—

(1) A gasmaking programme can be drawn up for the whole Company for several years in advance to cater for major repairs and future extensions.

(2) The most economical plants can be worked on the highest load factor.

(3) The carbonising plants, which are extremely costly in capital, are worked on a high load factor, whereas the cheaper plants, such as producer gas dilution plants, which are cheap to buy but comparatively expensive to run, are worked on a low load factor.

(4) Day to day peak loads are taken up by one station only.

(5) Considerable economies in fuel are made by the steady running of the majority of the plants, such as carbonising and steam raising equipment.

(6) The variations in the demand for coke can be catered for economically by varying the use of carburetted water gas plants.

(7) A planned repair programme is drawn up to give steady work to the centralised construction and maintenance department without undue peaks.

(8) Each works handles that coke traffic for which it is best equipped, and coke is stocked at Garston Works, which is close to the docks through which a large volume of the export business is done.

(9) By a considered coal and coke stocking programme, mobile plant, comprising mechanical shovels, dumpers and diesel driven cranes, is used most economically.

(10) A considerable economy in standby plant is effected by spreading the risk of breakdown between the four works instead of relying on complete availability of all the works all the time.

(11) By considering each works as a part of a large undertaking, the future plant requirements of the Company can be better appreciated. In the same way, with interlinking, the storage requirements of the undertaking have been reduced, and it is possible to plan for future needs and disposition to meet peak loads and district requirements.

(12) By the use of a centralised construction and maintenance department which has a high load factor and is therefore fitted out with efficient but expensive machinery, repairs at works are carried out expeditiously and skilled manpower can also be concentrated in cases of emergency.

Other benefits that have been obtained as a by-product have been the ability to carry out large-scale tests on works plant over an extended period; the rapid interchange of ideas; standardisation of equipment; reduction in spare parts and ability to introduce block holidays for works.

This list sounds formidable, but we have found that almost all these objectives have been attained. In view of the current interest in interlinking undertakings, it is felt that some broad indication of the means that we have employed will be of interest:—

(1) Convincing the works personnel that by unified working their status is not reduced but that, in effect, they occupy more important positions in management.

(2) A good costing scheme, which is essential in order to obtain up-to-date information about the running costs for various plants.

(3) A forecasting service controlled by a statistician to predict the sales of gas on both the long and the short term basis.

(4) A central control to organise the transfer of gas between stations and the collection of figures, hourly, referring the make and sales to the forecast for the day. This system enables us to distribute 43 mill. cu.ft. of gas per day with a maximum holder stock of under 20 mill. cu.ft.

(5) A centralised construction and maintenance department, which frees the works management from many of the tasks on the works which are irrelevant to the prime task of production.

(6) A central laboratory for the investigation of special problems and carrying out of routine tasks, which frees the works chemical staff for productive work.

PRODUCER GAS DILUTION OF COKE OVEN GAS

By S. H. STOKES, M.Inst.Gas E., M.Inst.F., Local Manager, Wath, Bolton and Thurnscoe Undertaking, East Midlands Gas Board

IN the Spring of 1946 considerable Press publicity was given to the fact that my undertaking was unable to renew the gas supply, discontinued before the war, to a local brickworks with gas engine operated plant.

It was just at this time that post-war housing development in the area had begun, and the various local authorities therein had been advised that progress could only be assured if adequate quantities of bricks, then in extremely short supply, could be obtained from local sources. Not only therefore was an immediate responsibility placed directly upon the Board to fulfil its statutory obligation to provide a gas supply, but the publicity given in the event of its inability to do so could not but fail to reflect adversely upon the service which the Board had to offer, and seriously prejudice that local goodwill essential to the promotion of gas sales in other spheres.

It would seem paradoxical that an undertaking purchasing unpurified coke oven gas from a local source, at which it was then generally known that large quantities of surplus gas were being burnt to waste, particularly at weekends, should be restricted in the matter of gas supply. On the other hand many large metallurgical users, supplied by neighbouring undertakings, were already suffering from depleted gas supplies during normal working days of the week. In the case of my undertaking, however, the difficulty was caused by a restrictive clause in the purchasing agreement made some years previously, which established a deadline, already reached, in the quantity of gas which might be taken in the interests of industrial consumers, and thus condemned the area to perpetual sterility in this respect. Yet it seemed the inescapable duty of the Board to provide an immediate supply for the important purpose detailed above, and at the same time promote expansion in the use of gas for industry and other general non-domestic activities.

The unpurified coke oven gas purchased by the undertaking has always been of consistent composition and high calorific value, and for a period of years the practice had been to admit from 8-10% of ex-

cess air at inlet purifier to dilute the gas to the statutory calorific value of 500 B.Th.U. per cu.ft., and assist the working of the purification plant. The practice might be regarded as very undesirable from a technical point of view owing to the impetus given to corrosion of gasholders, mains, services, and meters. This problem was of particular importance in view of the high percentage of cyanogen in the crude gas, the corrosive tendencies of which were greatly accentuated by the excess oxygen. If, therefore, the air could be limited to 3% and a quantity of diluent gas admitted, the therms in the latter, plus the therms in excess of 5 per thousand cu.ft. in the incoming coke oven gas after dilution with air, could be regarded as therms manufactured by the undertaking, and be available for industrial consumption. Furthermore, as the gas taken for domestic and other legitimate purposes increased, so would the amount of extra gas increase, and always by an amount available for industrial consumption.

Problems of Economic Price

The essential consideration to be borne in mind, however, was that the purposes for which the gas was immediately required, i.e., motive power for brickmaking and possible development in the use of gas in the local glass manufacturing industry, would necessarily have to be produced at an economic price and certainly not exceed 5d. per therm. In this the 'free' excess therms referred to would be of great assistance in averaging out what would otherwise be a high cost per therm at which a diluent, e.g., producer gas, could be manufactured. On the other hand an immediate financial loss would undoubtedly be sustained since revenue could no longer be derived from an otherwise inert product, i.e., air.

Hence it was considered that the admission of 7% producer gas would enable the Undertaking to supply immediately 15 mill. cu.ft. per annum of extra industrial gas, as against the then minimum requirement of 5 mill. cu.ft.

Some 25 years previously the Board had put down a ¾ mill. cu.ft. hand-operated C.W.G. plant, and this had lain disused and derelict for the greater part of that time.

The plant's conversion for producer gas production was carried out as follows:—

The carburettor and superheater were dismantled and all connections and fittings removed from the generator; the gas and backrun openings in the latter were also bricked up and sealed.

Two semi-spherical M.S. plates with segments cut out to form a central opening 1 ft. 2 in. diam. were laid directly over the existing firebars. A 2 in. Meldrum steam air blower was fitted to the former blast connection and a cast iron inspection bend bolted to a new gas offtake cut 1 ft. 6 in. from the top of the vessel; in addition a 4 in. blow-off connection was fitted and pipe vented outside the building. The original blast valve was adapted to form a particularly effective isolating valve, and this in turn was coupled to the existing washbox by a section of 9 in. steel main. An efficient air cooler was adapted from the existing water cooled condenser by simply welding a plate completely over the exposed ends of the tubes. A connection from the cooler outlet was then taken via a 6,000 cu.ft. per hour exhauster, through a receiver and B.M. meter direct to the coke oven gas main at inlet purifiers.

Instrument and Control Equipment

Instruments and control equipment in use are:—

Generator. A steam pressure gauge at inlet Meldrum blower. A temperature recorder on gas offtake main.

Steam Line to Blower. A Drayton motorised steam valve with bypass.

B.M. Meter House. A Sigma recorder with electrical controller operating on gas drawn from inlet purifiers after addition of air and producer gas.

Suitable pressure gauges are fixed across the various sections of plant in the producer gas stream.

Operation

Air is delivered into the coke oven gas stream and closely controlled at 3% of the gas taken by means of a quadrant relief valve and B.M. meter.

The producer gas exhauster is worked at a constant speed, and a butterfly valve, incorporated in the bypass and coupled to a float type regulator operated by inlet gas, is set to give 2 in. water gauge pressure at inlet exhauster. Thus, with a 2 in. seal in the washer, the pressure at the top of the generator is approximately 4 in. water gauge. The seal in the regulator is such as to exceed the maximum likely to be reached at inlet purifiers, and a safety seal is fitted to the cooler to obviate any possibility of the regulator or washer seal being overcome.

The generator is charged thrice and clinkered once every 24 hours. Steam pressure is maintained between 45 and 60 lb. per sq. in. to ensure high efficiency of the steam air blower, and thus minimise condensation under the grate.

Producer gas made is directly controlled in relation to the C.V. of the incoming gas. Movement of the Sigma pen opens and closes the circuit to the motorised steam valve, and its working is indicated by suitable signal lamps placed adjacent to the recorder.

One man per shift only is required to control the intake of coke oven gas, operate the producer gas plant, and generally supervise the works.

Conversion and Installation Costs

Total outlay involved in the conversion was as follows:—

	£	s.	d.
Meldrum Blower and Generator Lining	177	13	3
Steelwork	35	0	0
2 Sigma Recorders and Electrical Equipment ...	137	9	4
Exhauster	122	5	0
B.M. Meter	152	6	0
Connections	180	0	0
Instruments	27	12	9
Sundries	56	12	9
Labour	343	9	11
	£1,232	9	0

Working results of the plant during the first few months were very satisfactory and the Board decided to obtain a duplicate plant forthwith. Accordingly, an unused second-hand 20 therm suction plant has been purchased and installed adjacent to the No. 1 unit.

In this case the outlet of the Holmes-Connersville electrically driven exhauster is connected to the inlet of the existing washer with a suitable isolating valve fixed in the pipeline. A 4 in. motorised butterfly valve is incorporated in the blower bypass and this is operated by the Sigma controller through a two pole changeover switch inserted in the relay.

Installation costs of this plant were:—

	£	s.	d.
Plant and Haulage ...	316	4	0
Generator Lining and Fittings	152	13	9
Motorised Valve, Electrical Fittings and Wiring ...	76	6	3
Sundries	57	8	2
Steelwork	44	16	2
Labour	424	14	7
	£1,072	2	11

STATEMENT OF PRODUCER GAS MANUFACTURED YEAR ENDED DEC. 31, 1948.

Producer gas made ...	21,749,000 cu.ft.		
Air admitted, 5/6th of total metered ...	5,819,000 cu.ft.		
	£	s.	d.
Coke, 149 tons	536	5	5
Coal (for steam raising), 94 tons	186	14	9
Gas, 288,000 cu.ft.	21	12	0
Electricity, 480 kWh. ...	4	0	0
Water, 200,000 gal.	15	0	0
Labour	135	13	5
	£899	5	7

Producer gas made per ton of coke ...	146,000 cu.ft.	
	CO_2	CO
Producer gas analysis % ...	6.3	27.2
Town gas, average C.V. 497 B.Th.U. per cu.ft.		
Net profit on process after allowance for equivalent volume of diluent air ...	£1,148	17 7

STATEMENT OF INDUSTRIAL GAS SALES, YEAR ENDED DEC. 31, 1948.

	Thous. cu.ft.
Industrial gas sold (glass and brickworks)	19,499
Less authorised sales under Agreement	14,000
Excess industrial gas sold ...	5,499
Surplus gas for disposal 21,749 − 5,499 =	16,250

The whole of this surplus will be taken up in the current year by expansion in the manufacture of exportable high grade glassware.

Symposium continued on page 732

Details of the 'Ty-rock' full floating screen are given in a leaflet published by International Combustion, Ltd., 19, Woburn Place, London, W.C.1. The plant has been designed to effect in considerable capacity the coarse and medium sized screenings of crushed rock, gravel, ores, coal, and other materials. It is manufactured with one, two, or three surfaces in two widths and four lengths, and all models are provided with quickly replaceable screen sections.

SYMPOSIUM OF SHORT PAPERS

SOME ASPECTS OF OPERATING A BASE LOAD GASWORKS

By J. M. BROWN, B.Sc., Works Manager, Liverpool

A BASE load works, as we understand it, is one in which the whole of the gasmaking plant is maintained at full output the whole year round for a period of years. Weekend, holiday and peak load variations are not allowed to interfere with the operation of such a works.

The continuous vertical retort installation at the Athol Street Works of the Liverpool undertaking produces 2,500 mill. cu.ft. of gas per annum from 60 W.D. 62 in. retorts. It began operating under the defined base load conditions some two and a half years ago and is expected to continue in this way for a further two and a half years before one section is shut down for examination and repair.

The seasonal excess gas and coke production at this works is absorbed by suitable inter-works arrangements.

Experience of full output conditions indicates the following points:—

(1) The overall working life of the retorts will be increased. This life can be assessed as 'tons of coal carbonised per 10 in. retort major axis.' An accepted figure on this basis is 2,500 tons during the retorts overall life, i.e., from rebuild to rebuild. During such a life two retort face repairs are usually required.

On existing evidence we expect to carbonise 1,600 tons per 10 in. retort major axis (i.e., 64% of the total average life) before the first retort face repairs are required. If base load conditions are maintained, an overall life of 3,000 tons per 10 in. retort major axis is anticipated; that is an improvement of 20%.

It is submitted that the excellent condition of these retorts is due largely to the fact that heat racking of the refractory material is reduced by continuous full output working. Many plants reach premature old age owing to intermittent idling and failure to keep the plant operating under steady rhythmic conditions.

Need for Continuous Operation

(2) The second aspect of this policy is concerned with plant operation.

The aim of the carboniser is to obtain maximum thermal output per ton of coal, and per retort, with the minimum expenditure of producer fuel. Such aims cannot be achieved unless the plant is worked for extending periods without interruption.

During this period of base load working at Athol Street we have had three inevitable short idles for ancillary plant modification. Maximum output was not completely regained until two or three weeks after these idles.

As the final control of calorific value on this works is obtained by admission of externally-made producer gas, no alterations to carbonising plant conditions are necessary to accommodate variations in coal quality. This technique has already been reported in the technical press.

Under continuous full output working, modifications in plant technique can be studied, and reliable conclusions obtained. This particular plant is, in fact, used for large-scale test purposes. The steam production and demand is constant, and no solid fuel fired boilers are necessary except when waste heat boilers are shut down for annual survey.

(3) The third aspect worthy of note is oxide purification. Difficulties might be expected with oxide purification on high output of gas maintained without the usual summer easing of the load.

A Study of Purification Problems

It is true we did have trouble in the first summer, owing to inadequate gas condensing capacity, but this was speedily overcome. The purifier programme is planned until 1951, and the discharging routine is now established with a steady rhythm. Peak demands for labour, so common in many works, have been smoothed out, and an experienced team of men is engaged full time on purifiers.

The constant rate of gas flow has made possible a valuable study of purification problems. Some results of these investigations have been reported by the Gas Research Board, and more recently by Mr. L. C. Townsend, of Liverpool.

We confirm that hardening of oxide and back pressure troubles are decreased with high rates of gas flow and short box life. The problem of working up the oxide to 45% sulphur and over without transferring the semi-spent material to works operating with lower load factors has, however, yet to be solved.

(4) My final point concerns the effect of base load working on personnel. Most shift-workers on a gasworks are resigned to seasonal working, with a serious drop in their average weekly earnings during the summer. It is idle to suggest that this does not affect the man's attitude to his work. It is difficult to assess this factor, but I am convinced that the men employed at this works have developed an unusual interest in their jobs.

The fluctuations in labour requirements are a minimum, and this factor leads to a closer study of the duties involved than would be possible under varying output conditions. On such a base load carbonising plant facilities are available for training technical personnel in ideal carbonising technique.

Finally, by way of postcript, I should like to say that my colleague and I appreciate and acknowledge the encouragement received from Mr. Leach, General Manager, and Mr. Hubbard, Engineer to our undertaking, in the preparation of these short papers.

DETERMINATION OF THE MOST ECONOMIC WORKING PRESSURE AND DEGREE OF SUPERHEAT FOR GASWORKS WASTE HEAT BOILERS

By STANLEY JONES, M.I.Chem.E., M.Inst.Gas E., Engineer and Manager, Western Section, Middlesbrough Division

THERE appears to be a considerable difference of opinion among gas engineers about the most economical working pressure and the degree of superheat to be allowed on waste heat boilers, although most engineers agree that the existing standard of 120 lb. per sq. in. pressure with 50°F. of superheat is too low. The necessity to erect a considerable amount of new carbonising plant in the near future makes this point important.

The general position in regard to generating plant in gasworks has also undergone a fairly marked change during the past few months under the stimulus of the nationalisation of the electricity supply industry, the nationalisation of the gas industry, and the intensified efforts of the Ministry of Fuel and Power to bring about maximum fuel economy throughout the country. Whereas in the past high efficiency of steam-driven plant in gasworks was not a matter of major importance, the fact that the British Electricity Authority are now prepared to accept generating plant in gasworks running in parallel and actually feeding back surplus current into the supply lines has completely altered the picture. It is now possible and most economical for a gasworks to install generating plant equivalent to the maximum capacity of its waste heat boilers, to drive the various pieces of machinery in the works electrically and to export any surplus power to the outside mains at a relatively good price.

Three Factors

The determination of the most economical working pressure is controlled by the following factors:—

(a) The higher the pressure and amount of superheat, the lower is the amount of energy required in the form of steam to perform a unit of work.

(b) In order to obtain higher pressures on a waste heat boiler, the outlet gas temperature has to be raised and consequently there is less heat converted into steam. There is a point, therefore, where the most advantageous condition of pressure and superheat expressed as the total heat of the steam is attained, beyond which the loss of heat due to high outlet waste gas temperature more than neutralises the economy obtained from higher pressures and superheat.

(c) A third factor which requires consideration is the increased capital cost of the boiler, pipelines and engines, designed for working at the higher pressures. The larger the installation the higher are the pressures which can be justified on the basis of cost.

The purpose of this paper is to indicate

briefly the influence of the various factors, so as to assist in the determination of the most suitable pressures and degree of superheat for economical working, based on factors (a) and (b) and on actual performance figures for engines operating on varying pressures and degrees of superheat, as quoted by the makers. The performance figures apply to engines consuming from 15,000 to 25,000 lb. of steam per hour, and they are an average of the figures quoted by various makers. The effect of factor (c) will depend on the size of the installation, and the most advantageous boiler condition for individual installations may be determined by the relationship between (a) and (b), on the one hand, and the price factor (c) on the other hand.

Standard Conditions

Certain standard conditions have been assumed, and it is assumed that the steam is utilised to drive engines exhausting as follows:—

(a) Into a surface condenser,
(b) to atmosphere, and
(c) against 20 lb. per sq. in. pressure.

The standard conditions assumed are as follows:—

Inlet waste gas temperature to waste heat boiler = 832°C. = 1,530°F.

Outlet waste gas temperature from waste heat boiler = 50°C. above saturated steam temperature = 90°F.

Waste heat steam made at 120 lb./sq. in. and 75°F. super-heat = 1,300 lb. per ton of coal carbonised.

Loss of superheat between boiler and engine = 25°F.

Inlet feed water temperature = 180°F.

The standard outlet temperature of 50°C. above saturated steam temperature may be reduced by the boiler designers as higher pressures are adopted, and the outlet temperature of the waste gases is safely above the dewpoint. This would result in increasing the efficiency of boilers, at the higher ranges of pressures, above the standards adopted in this paper.

It is understood that the present design of the standard waste heat boiler is limited to a maximum steam pressure of 275 lb. per sq. in., and to design a boiler to withstand higher pressure would involve considerable added cost. The same applies to steam stop valves and feed valves.

When deciding on the pressure to be adopted in a waste heat boiler, the purpose for which the steam is to be utilised must be considered. Processes such as steaming vertical retorts, benzole distillation, dehydration plant evaporators, tar distillation, and heating of shops and offices, are likely to absorb up to 50% of the total steam made in the waste heat boilers. In these cases, steam pressures of the order of 10 lb. per sq. in. to 20 lb. per sq. in. are suitable. If these conditions apply, then the boiler pressure should be suitable for driving an engine exhausting into a condenser and also an engine exhausting against a back pressure. Alternatively, good use might be made of an engine of the extraction or pass-out type, particularly if conditions are such that the power load and process requirements are of a variable nature and not coincident.

If a back pressure of 20 lb. per sq. in. is required, the lowest steam pressure at the engine to allow for the use of a compound engine would be 145 lb. per sq. in., and for a back pressure of 40 lb. per sq. in. a steam pressure of 210 lb. per sq. in. would be needed. Triple expansion engines are not normally designed for operating against a back pressure at the lower ranges of boiler pressure.

The Steam Turbine

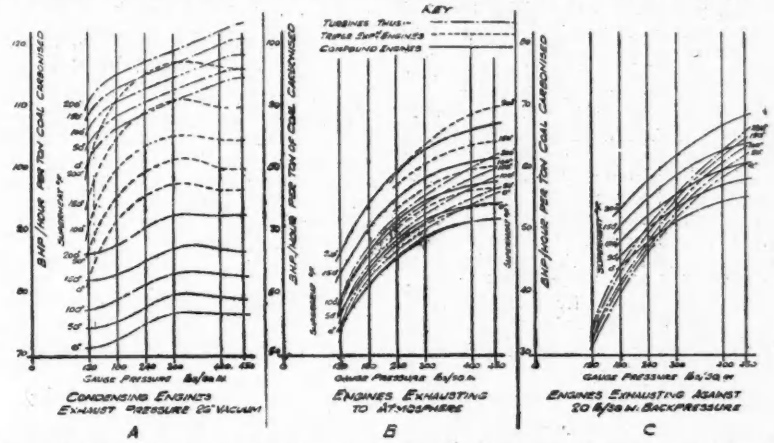
Modern trend is towards the use of the steam turbine even on the smaller installations, and they have an efficiency equal to or greater than that of the triple expansion engine when exhausting into a condenser, but when exhausting against a back pressure the performance of the steam turbine falls rapidly and it is less efficient than a compound engine working under similar conditions.

An efficient manner in which to operate a steam turbine in order to obtain exhaust steam for process work is to use a 'reducing' turbine, which is designed so that steam in varying quantities can be withdrawn at an intermediate stage whilst the final exhaust discharges into a condenser. A table has been compiled by the author to determine the effect of different steam pressures and degrees of superheat on the overall efficiency of a waste heat boiler, expressed as the b.h.p. hour per ton of coal carbonised.

Graphs A, B and C have been developed from the table and show the output from a waste heat boiler when using different types of engines under varying exhaust conditions.

From a study of the table and graphs it is evident that, notwithstanding the lower quantity of heat recovered from the waste gases at the higher steam pressures, amounting to a decrease of 10% between pressures of 120 lb. per sq. in. and 450 lb. per sq. in., the increased operating efficiency with steam at the higher pressures still gives an increased overall efficiency. The increase in efficiency, however, above 250 lb. per sq. in. to 300 lb. per sq. in. is comparatively small, and it is doubtful whether higher steam pressures justify the increased costs of equipment and maintenance. Generally speaking, in the case of turbines the normal steam pressures adopted for machines developing 700 h.p. to 1,400 h.p., *i.e.*, suitable for driving electric generators with a capacity of 500 to 1,000 kWh, is from 250 lb. per sq. in. to 300 lb. per sq. in. For larger machines, higher pressures are adopted.

For economical operation of engines the advantage of a high steam temperature is evident, and a high degree of superheat, say 200°F., should be aimed at.



SUGGESTION FOR CONSERVING REFRACTORY MATERIAL

By A. F. COTTRELL, M.Inst. Gas. E., (London)

THIS is an effort to present the latest information regarding hot patching of carbonising plants by the spray welding process and to explain the part it can play in conserving refractory materials which are still in such short supply.

It is well known that all retorts, chambers, or ovens are liable to develop leakage or other faults which can result in early failure and a premature demand for new refractory material. It is, therefore, in the national interest that deterioration should be tackled resolutely while the plant is at working temperatures.

The practice of using wet slurries for hot repairs, which was general a few years ago, has now been superseded in some cases by the more scientific method of 'blow-pipe spray welding' which was so ably described by Messrs. Rhead, Hawthorne, and Deacon, of the Birmingham Gas Department, in 1938 when it was in its infancy. In that paper, work on relatively small leaks was discussed, but the authors mentioned the possibility of extending the usefulness of the process to cover the building up of spalled or flaked areas.

Fortunately their pioneering efforts have

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been followed up in the past 11 years by extensive work on a number of carbonising plants, during which time alterations have been made to the burner assembly, the cement grading, and the cement feeding device. These changes have each resulted in improved, faster and more regular working of the system, so that building up of eroded or damaged areas is now accepted as a practical possibility. In addition, apparatus has been developed for use in coke ovens and at the present time one or more types of multiple burners are being tried out in Birmingham to increase the scope and output of the welding equipment.

It is not necessary here to go into details of the process other than to say that it is the application of finely divided silica powder in a fused state to the damaged areas. An oxy-coal gas flame is used and special cement is fed to the burner head in a stream of oxygen. The oxygen pressure is regulated by the usual gauges and the cement feed is easily controlled by a lever on top of the container. The flame is positioned about 1 in. from the area to be welded and the weld material can be applied smoothly and evenly. The work certainly calls for trained men but the necessary skill can be acquired by a normally intelligent workman in a few weeks.

Numerous retorts, chambers and coke ovens have been and are being repaired in this way. The work varies in extent from 'pin-holes' to badly eroded or holed areas in retorts and from leaking brick joints to spalled or eroded walls in coke ovens. It will be appreciated, therefore, that the process is applicable within very wide limits and cold inspections made months after spray welding has been carried out have shown that a properly welded area is a sound repair which will withstand the passage of coke without detriment.

It is known that there are many plants where the determined application of spray welding has allayed deterioration to such an extent that it has been possible to defer cold repairs of gas ovens to lengthen their life for a still longer period.

'A Stitch in Time'

It need hardly be stressed that the best procedure is to adopt spray welding as soon as the first leak appears and to make sure that small leaks are not neglected and allowed to become enlarged.

If, however, there are difficulties in adhering to this practice, or if for any reason larger areas have been damaged, it is still possible to make a good repair. If necessary, bricks can be inserted in holed areas and welded into position.

The three following examples are typical of the special work which is being carried out with a view to extending life and saving refractories.

(1) Increasing outputs made it impossible for a certain undertaking to adhere to its pre-arranged resetting programme, with the result that a section of four retorts which were well over-due for cold attention developed a number of holes. The welding process was brought into operation with two gun teams which worked for about a fortnight on each retort in the first instance and then for a day or two at subsequent scurfings. Although the damage became acute about 18 months ago, the welding was so effective that the retorts are still working.

(2) The trouble in this case was due to late delivery of materials which made it necessary to keep an old bench of intermittent vertical chambers at work for a further year. This would have been impossible except for the welding process which kept every chamber at work until the house was eventually shut down.

(3) Deep erosion had been caused in the bottom 1 ft. to 1 ft. 6 in. of some coke oven side walls by the use of wet coal. This was built up to the original line of wall by two welders at the rate of 1 ft. to 1 ft. 6 in. of wall length per day. These ovens are now working quite normally and their life has been extended by several years.

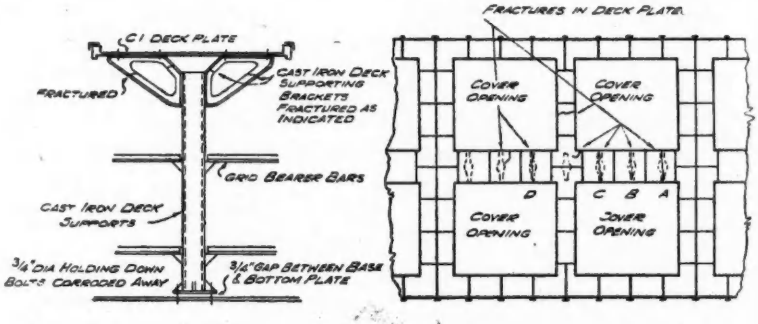
This system of repair has definitely been proved successful. It can be of extreme value in combating leakage, thus decreasing thermal loss and increasing revenue; in extending retort life, thereby saving refractory material, and in overcoming difficulties if the present day shortages make it necessary to carry on with plant which would ordinarily be renewed.

The above advantages, together with easier temperature control (resulting from elimination of leakage), would appear to be more than sufficient to offset the cost of applying the process.

FRACTURE OF CAST IRON BRACKETS AND BALCONY PLATES ON PURIFIERS

By STANLEY JONES, M.I.Chem.E., M.Inst.Gas E., Engineer and Manager, Western Section, Middlesbrough Division

AN item of interest concerning purifiers is an experience which we underwent three winters ago due to fracture of some of the cast iron brackets supporting the deck plates. The accompanying sketch indicates the location of the brackets.



ELEVATION THRO' BOX SHOWING DECK SUPPORTS & BRACKETS

PLAN OF PURIFIER DECK PLATES (SHOWING FRACTURES)

It was evident that all the fractures were not new.

Some two weeks later it was again thought that the centre deck plates were lifting and this was verified by observing the movement of a spirit level with the pressure on, and shut off. The box was shut off before any damage had been done to the plates. On examination it was finally discovered that the heads of the bolts securing the base of the centre column had been completely corroded away, and that there was a clear space of ¼ in. between the bottom plates and the base of the column. The other column bases were then all examined and further bolt heads were found corroded away as shown in the sketch above, but the centre column was the only one which was found to have lifted.

One afternoon the deck plates of one of the boxes were observed to have lifted and were bulging upwards in an alarming fashion. The box was immediately shut off, the covers removed and brackets *A*, *B*, *C*, and *D* were found to have fractured. It was impossible to obtain new ones without considerable delay, so we immediately commenced making replacements ourselves from 3½ by 3½ by ⅜ in. angle. The work was completed and the box was again at work by the following afternoon, the fractured deck plates being plated above and below.

The maximum pressure on the purifiers had not exceeded 40 in. w.g. around the time of the occurrence, although it had previously been as high as 48 in. w.g. We came to the conclusion that the cause of the fractures was due to an explosion which had occurred in the adjacent box some two years previously, slightly fracturing some of the brackets, and the extra strain of dealing with larger volumes of gas had finally caused complete fracture.

The bolts have now all been renewed and have been well covered over with bitumastic compound similar to that which had been used to protect the cast iron bottom plates. This bitumen compound 'Kauxene' is used for caulking the seams of ships' decks, and has been used for the past 17 years in Middlesbrough for protecting purifier bottoms, and has proved a complete protection against corrosion where concrete which had been

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previously used had failed. There is a greater tendency for corrosion in our purifiers than is normal, due to the complete extraction of ammonia from the gas at the coke ovens, and the consequent acid nature of the condensate.

Our final conclusions regarding the above occurrencies are that the central column lifted first; this increased the vertical load on columns *D* and *C* leading to the fracture of the brackets on *C* and *D*. This resulted in a progressive increase in the load which was consequently followed by the fracture of brackets *A* and *B*. All this was aggravated partly by the general condition of the brackets, and the strain set up by vibration caused by a heavy overload. The fracture of the deck plates followed inevitably on the fracture of the brackets.

The force acting upward on the inside of a box is the internal gas pressure. The force acting downwards is the weight of the deck plates, purifier covers, deck supporting columns, grids, grid bearer bars and oxide.

The weight of these items in our purifiers, per box, is as follows:—

	Tons.
Deck plates	3.6
Deck supporting columns and brackets	3.4
Purifier grids	0.8
Grid bearer bars	0.5
Purifier lids	6.0
Iron oxide	150.0

Iron oxide accounts for practically all the weight and can be taken as averaging 60 lb. per cu.ft., *i.e.*, practically the same weight as water.

If the column holding down bolts at the base of the box are corroded away and the internal pressure of a box measured in inches water gauge is greater than the depth of oxide measured in inches, there is danger of the deck plates lifting and fracturing. If the grid bearer bars have partially collapsed and the weight of the oxide is not completely carried by the columns, the danger is further aggravated.

RELAYING LONG SIDE-SERVICES BY ROLLING A COPPER TUBE THROUGH AN OLD SERVICE

By H. E. F. HEATH, M.Inst.Gas E., A.M.I.H. and V.E. Mains Engineer, Commercial District, North Thames Gas Board

BECAUSE of the excessive cost of relaying long services since the war—principally as regards reinstatement charges, compressor costs, and wages—experiments were started some months ago with the object of pulling new copper pipes through old wrought iron services under a road. More than 50 long side-services have now been relaid in this way, and the following is a brief description of the savings and other advantages thought to accrue from the use of the system.

The tools required to relay a service

Fig. 1.—The lever in position. The cable can be seen entering the old service pipe. The snatch-block is below the operator's hand.

in this way are simple and inexpensive, consisting of the following: a special lever with which a pull of about 1,000 lb. can be applied, and which is fitted with a snatch block; two spiral wire flue brushes with hooks welded on to each; two $\frac{3}{16}$ in. wide cables with soft eyes spliced on the ends; and a 'dolly' for attaching a cable to the copper tube. The material used is fully annealed copper tube, B.S.1386, 1947, which is obtainable in coils, in lengths of 30 to 60 ft. In old 1 in. services $\frac{3}{4}$ in. inside diameter copper tube is used, and 1 in. in old $1\frac{1}{4}$ in. services.

To relay a service, trenches are dug—one over the main and one in the opposite footway—and the old service is sawn off

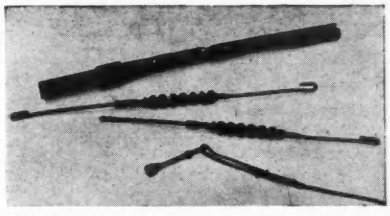

Fig. 2.—(A) An example of an old service pipe referred to in the paper. (B) Two of the brushes which are used in the operation. (C) A 'dolly' attached to a $\frac{3}{16}$ in. cable.

short in both trenches. The unwanted parts of the old service are then removed, and the main plugged temporarily. The next operation is to loosen the corrosion in the old service with a clearing wire, and then to blow out as much rust as possible with a compressor or force pump. After this, one of the $\frac{3}{16}$ in. cables is pulled through the old service by means of a clearing wire, and the cable and lever are used to pull through a wire brush of approximately $\frac{1}{4}$ in. smaller diameter than that of the old service pipe. The second cable is drawn through behind the brush, and is used to pull back the first cable afterwards, as the brushes and copper tube are all pulled through in one direction only. The smaller brush having been pulled through once or twice, as required, the operation is repeated using a brush of the full diameter of the old service pipe.

The above operations are easier with old dry services than with wet ones; but, when using the lever, the brushes have often been pulled through wet services which were so corroded as to be full of holes, and almost completely choked.

The old service having been thoroughly cleared, the 'dolly' is inserted in one end of a coil of copper tube, and the

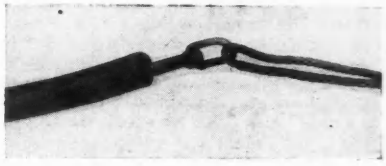

Fig. 3.—The 'dolly' inserted in the copper tube ready to be pulled through an old service.

copper well hammered around it. The tube is then pulled through the old service by means of the lever and a cable attached to the 'dolly,' and the tube smeared with old engine oil as it enters the old service. The tube can be pulled through quite easily with one hand on the lever, and so suffers no damage in its passage.

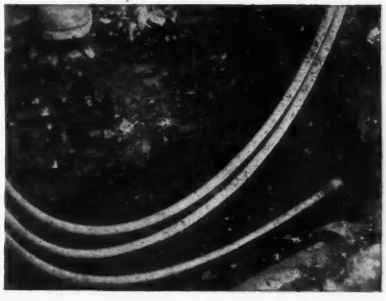

Fig. 4.—The other side of the road shown in Fig. 1. The coil of copper tube is in the early stages of being pulled through an old service.

Finally, the extreme end of the copper tube containing the 'dolly' is sawn off, and the other end sawn off to suit; couplings are fitted to each end of the copper tube, and the new service connected up to the main and to the meter, and the couplings wrapped with Denso.

Relaying by the method described

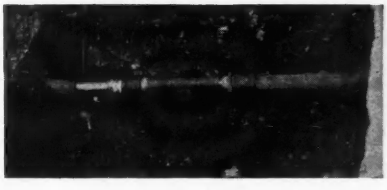

Fig. 5.—The finished job.

effects a very great saving in time, as a service can be relaid from footway to footway in a morning, quite irrespective of the type of road surface. This fact, and the enormous reduction in reinstatement charges, far outweigh the extra cost

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of copper tube, and account for most of the savings.

Allowing for varying types of road surfaces, and averaging the different borough council's paving charges, it is found that the average cost of relaying a long side-service by the usual method in the East End of London is £28 15s. When copper tube is pulled under the roadway, all else being equal, the average cost is £12 15s., a saving of 55% or £16 per service relaid.

It is true, of course, that this method of relaying results in the new service being smaller than its predecessor, but this is offset to some extent by the smooth bore of the copper tube. It is also thought that a ¾ in. copper service that will retain its original bore is as effective as a 1 in. service that in due course may corrode to an inside diameter of far less than ¾ in. It has been found, by the use of a pressure recorder, that a 20 ft. long ¾ in. copper service, continued to the meter with 20 ft. of 1 in. pipe, is more than ample for a house occupied by two families, both using gas cookers.

There is also the question of electrolysis; but, the copper being the cathode, it should be the old wrought iron service which, being the anode, would be corroded, and not the new copper service.

Finally, there are thought to be advantages, apart from financial ones, in the use of this system. For example, there are no joints under the carriageway; the new service is assured of the correct fall, and a good bed; and it is protected both mechanically and to a great extent from soil corrosion by the old service pipe. In fact, a copper tube surrounded and protected by a wrought iron pipe should be almost an ideal arrangement, and have a very long life indeed in all but the most highly corrosive soils.

ELECTRICAL ANTI-FREEZING APPARATUS FOR GASHOLDER CUPS

By W. R. GARRETT (Newcastle)

THE erection of gasholders on sites where steam or hot water is not already available necessitates the careful consideration of suitable anti-freezing apparatus. Such a holder was erected at a virgin site on the northern outskirts of Newcastle-upon-Tyne some miles from the nearest gasworks, and the ultimate selection of suitable anti-freezing equipment was electrical heating elements inserted in the cups.

The holder is spirally guided, has a capacity of 3 mill. cu.ft., and is constructed in a partly submerged reinforced concrete tank with coping level 14 ft. above the surrounding ground. The dimensions of the holder are as follows:

Inner lift	...	204 ft. by 30 ft. 9 in. deep
Middle lift	...	207 ft. by 30 ft. 9 in. deep
Outer lift	...	210 ft. by 30 ft. 9 in. deep

The tank is 216 ft. diameter, and provision has been made for the addition of a fourth lift at some future date. The cups are 12 in. wide by 1 ft. 10½ in. deep.

To determine the size of heating elements, tests were carried out in the winter of 1945-46 to obtain the heat losses in the cups of existing holders. Working on the assumption that there is about 20° of frost, the rate of heat input required to compensate for the heat lost in each cup amounted to the equivalent of about 2°F. per hour. On the basis of approximately 66,000 lb. of water in each cup for the new holder, and assuming 90% efficiency, the requirements are thus approximately 45 kW of electric energy per hour, or 1/16 kW/ft. run of cup.

The heating elements each consist of 700 ft. of standard 3-core copper-sheathed Pyrotenax 0.0015 cable star-connected at one end, and supplied complete with 10 yards of 3-core 0.0145 lead-in cable for connection to the 415-volt, 3-phase, 50-cycle supply. The elements are laid in mild steel hook straps attached to the dip plates and are positioned about 1 ft. 4 in. below the cup water level. The electric supply to each cup is transmitted through flexible armoured cables which rewind automatically on to Wayne self-winding drums according to the position of the holder.

The control gear is mounted in a sheet steel cubicle approximately 5 ft. 6 in. high by 2 ft. 3 in. wide by 2 ft. deep, and is housed in the adjoining governor house. It contains the necessary switchgear, H.R.C. cartridge fuses, indicating lamps, ammeter, voltmeter, kilowatt-hour meter, &c. A cable connects the governor house control gear to a flameproof pattern bus-bar chamber and ironclad flameproof 60-amp, triple-pole, interlocked, air-break switch units situated near the holder from which the supply is connected to the Wayne reels at coping level.

The electric supply to the heaters is arranged to switch on automatically by thermostats when the temperature of the water in the cups drops to 36°F., and cuts out when it exceeds 40°F. The thermostats are arranged to control the main circuit-breaker in the governor house. A warning light indicates whether the current is on or off.

It should be noted that in this particular instance the electric heating applies only to the cups. The water in the tank has no heating and, for maintaining ice-free conditions, reliance is placed on circulating the water with four electrically-driven agitators situated around the periphery of the tank.

Because of the comparative mildness of the last two winters, complete working experience of the system has not been possible; but, subject to the thermostats functioning correctly, it should prove a successful alternative to the older systems of steam or hot water heating. The Oxley Engineering Co., Ltd., were the main contractors for the gasholder, and all anti-freezing equipment was supplied by their subsidiary company, Thos. Dryden & Sons, Ltd., Preston.

A NEW METHOD AT CONTROLLING THE COMBUSTION OF TOWN GAS

By F. BRINSLEY (London)

THIS new method of controlling the combustion of town gas depends upon the calyx flame phenomenon.

Using a burner of very simple design (Fig. 1), town gas is passed in at *A* and air in slight excess at *B*. Mixing occurs in the chamber *C* and the flame at *D* has a short lilac-coloured inner cone and a blue outer mantle. A glass cylinder, *E*, is placed round the flame. The joint at the base of the cylinder is air-tight, and the outlet in the refractory plate at the top is so small that while products can escape no air can enter. After a minute or two the air in the cylinder has been completely displaced and thereafter the flame continues to burn in an atmosphere of its own products.

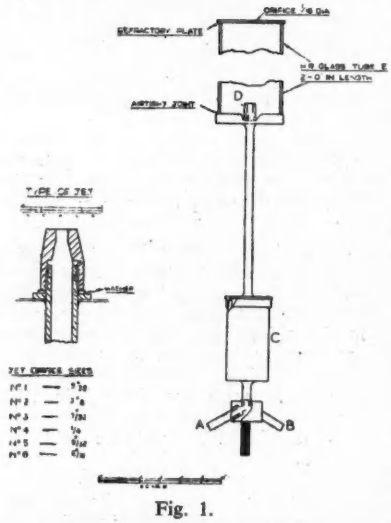

Fig. 1.

Fig. 2.

The flame remains quite steady provided the jet orifice is of suitable size and the gas and air supplies do not fluctuate. If the gas rate is kept constant and the air rate is slowly reduced pronounced changes occur as the amount of air approaches that required for complete combustion of the gas. The upper part of the outer mantle becomes reddish, and then the mantle suddenly lengthens by fivefold or more; this is followed by a decrease in length, and

at the same time there appears a separate volt flame at the base of the main flame completely displaced and thereafter the flame continues to burn in an atmosphere of its own products.

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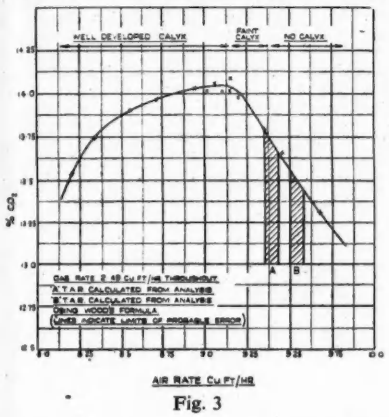

Fig. 3

required for complete combustion of the gas. The upper part of the outer mantle becomes reddish, and then the mantle suddenly lengthens by fivefold or more; this is followed by a decrease in length, and at the same time there appears a separate violet flame at the base of the main flame (Fig. 2). This is the calyx flame, and a spectrogram shows that it is due to sulphur, S_2. In a dark room persons with eyes having good sensitivity in the blue-violet region of the spectrum can discern this calyx flame when the sulphur content of the town gas is less than 1 grain per 100 cu.ft.

The first appearance of the calyx flame occurs when the air/gas ratio is correct for complete combustion, and it provides a suitable criterion for the determination of the total air requirement of town gas indicated in Fig. 3, which also shows that the total air requirement does not coincide with the peak of the carbon dioxide curve.

By measurement of the rates of flow of the gas and air respectively the total air requirement (T.A.R.) of town gas may be determined quickly, visually, and with an accuracy of ± 1.5%. The method is suitable for continuous observation. In the case of premixed gas and air a portion of the mixture is passed through a flame trap and then to the T.A.R. burner.

A knowledge of the total air requirement of town gas at the moment of use is valuable where it is desired to control the combustion conditions, for example in a furnace, so that a reducing, neutral, or oxidising atmosphere may be attained. The T.A.R. burner gives results which are trustworthy, and members will no doubt find it useful for many purposes.

SOME NEW IDEAS IN BURNER DESIGN

By T. MINCHIN, B.Sc.(London)

THE flat flame is still widely used, but some years ago I found great difficulty in attempting to discover why the flat flame was flat. It sounds a simple enough question, but it is not, I think, generally known. Fig. 1 gives my own explanation of the phenomenon. I shall be very interested if anybody con-

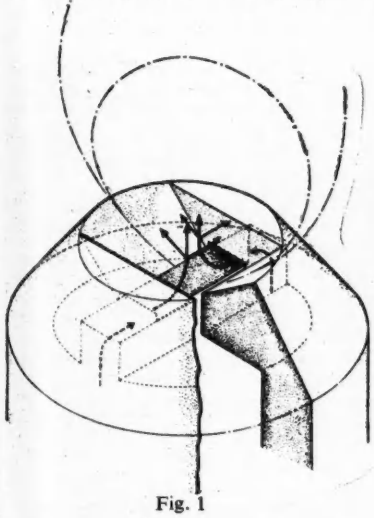

Fig. 1

tradicts me about it, because it seems to provide a working explanation. The essential point is, apparently, the cavity behind the orifice. I sometimes call this the wedge cavity orifice. The shape of the flame depends not on the shape of the hole itself—because the flat flame is at right angles to the slot in the burner—but on this cavity under the orifice. Currents of gas come down and form, as it were, an impinging jet mechanism, so that the flat flame is produced at right angles to the wedge cavity which lies underneath the actual orifice of the burner.

Using the same principle, one can go on to design different types of burners to obtain flat flames. The flat flame has the basic advantage that it gives a larger area of contact with the surrounding air than if it were circular. Fig. 2 shows a

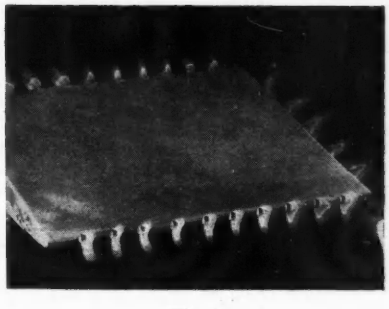

Fig. 2

burner which has been designed on this principle. It is a conversion burner for Ideal boilers. The wedge cavity runs right along the edge of the burner, and the aerated flames coming out are in fact flat flames. They are just the same shape as the ordinary Bray jet, but they are aerated flames with a blue inner cone, and are considerably more stable than the ordinary round flame from a round hole. The shape of the actual hole is not important; what causes the shape of the flame is the shape of the cavity behind the orifice.

Another example has been applied to an experimental burner which might be used as a boiling burner. Here again you have the cavity running right along the ridge and a series of cuts in the ridge giving a series of flat aerated flames.

One other rather useful application of this principle is in the use of the flat jet as an injector in aerated burners. If instead of having the ordinary round hole as the orifice in your injector you have instead an orifice of this type, giving a flat fan-shaped jet, it is obvious that you get more rapid mixing. This is particularly useful with burners burning butane or propane, where the mixing is particularly slow, and it is usually necessary to block off several of the first holes on going from town gas to butane because the mixing is so slow. By this kind of jet you get more rapid mixing and the direct conversion from a town gas burner to butane without lengthening the mixing part of the burner at all.

PRESIDENT'S LUNCHEON

(*continued from p. 698*)

integration of the gas industry under the area Boards. They envied Mr. Hendee his ability to head a £5 mill. research programme in America. It seemed a lot of money. We in this country were content to spend a much more modest figure, but he hoped that in a few years' time the unified gas industry would have seen the wisdom of collaboration and co-operation and be prepared to spend a very largely increased sum on research.

The Institution of Gas Engineers had a very fine Education Scheme of which they were all justly proud. They had not kept strictly to the professional side; they had seen the necessity for training the artisan section serving the industry. They had not overlooked the salesmen, and they would co-operate with the Gas Council in a wider education scheme to fit the reorganised gas industry. He wished to give an assurance that the Institution was very keen indeed to assist the Gas Council in any form, whether in education or in research, voluntary or otherwise, on the many committees which had done such good work in the past, or in the proper qualification of those to whom they would look for their administrators in the future. He could only say that during the last few years, with its very largely increased qualified membership and the obvious keenness of the junior members to become qualified, the Institution had shown that it was destined to play a most important part in the future of the gas industry.

Mr. **R. Lishman,** J.P., Chairman of the former Newcastle-upon-Tyne and Gateshead Gas Company, proposed the toast of 'The President' and complimented him on his conduct of that very happy gathering. He paid tribute to Mr. Crowther's wisdom and guidance. He had lived up to the highest traditions of his high office, and behind him had stood his guiding star—his wife.

The **President,** in a brief response, expressed especial appreciation of Mr. Lishman's reference to Mrs. Crowther.

Personal

Mr. W. J. RAWLINGS, M.A., B.SC., formerly Executive Officer, Scottish Coke Association, has been appointed Coke Executive Officer to the Scottish Gas Board.

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To mark his 50 years' service with the Nottingham gas undertaking, colleagues of Mr. WILLIAM HOLLAND, costing clerk at the Woodborough Road depôt, presented him on June 9 with a barometer and fountain pen.

* * *

Mr. C. S. SHAPLEY, O.B.E., asks us to express his thanks to the very many friends who have written to congratulate him on having received the honour of the O.B.E. on the King's Birthday. He hopes to answer them all personally in due course.

* * *

Mr. DONALD MCCULLOUGH has been appointed Public Relations Adviser to the Federation of British Industries. The appointment will not prevent his continuing to hold his existing directorships. He will work in collaboration with Mr. F. L. Stevens, Head of the Federation's Press Department.

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Mr. E. H. Moss was presented by Mr. C. A. Newham, Group General Manager, with a reading lamp to mark his retirement after 39 years' service with Bradford Gas Undertaking. Mr. Moss, who served under six gas engineers, starting at the Clayton works, became mains staff foreman at Mill Street works.

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Following the appointment of Mr. Alexander Tran to the position of General Manager of the Northern Division of the Southern Gas Board, Mr. S. C. BENTLEY, who was Assistant Engineer at Oxford, is now Engineer and Manager of the Oxford and District undertaking, which is the principal of the three groups in the Division. Mr. D. J. O. BATH, of Bilston, will shortly be moving to Oxford as Deputy Engineer and Manager.

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Mr. J. C. NEEDHAM, senior Managing Director of Evershed and Vignoles, Ltd., retired on May 31 after 48 years of service with the Company. He was elected to the Board in 1936 and became a Managing Director in 1940. For many years Mr. Needham was head of the Company's naval department, being responsible for the design of control apparatus for the Royal Navy ; some of his inventions are still used in the service. Mr. Needham retains his seat on the Board.

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Following his retirement from the Board of Ruston and Hornsby, Ltd., Mr. V. W. BONE, J.P., Chairman of Davey, Paxman and Co., Ltd., has resigned from the Chairmanship and Board of the Company after a long illness. Mr. H. RIGGALL, J.P., succeeds him as Chairman and Mr. P. A. SANDERS, C.B.E., D.L., J.P., becomes Deputy Chairman. Sir JOHN B. GREAVES, C.B.E., has been appointed Managing Director in succession to the late Mr. Edward Paxman, M.A. Mr. G. W. BONE, M.A., only son of Mr. V. W. BONE, was also recently appointed Works Director.

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At a meeting of the Sydenham Branch of the British Legion, on June 10, Mr. TOM BROWN, a member of the South Eastern Gas Board, and formerly Managing Director of the South Suburban Gas Company, was presented with a certificate of Life Membership of the Legion in recognition of meritorious services rendered to the Branch as its Patron for some years. The presentation was made by Lieut.-Colonel J. A. Gould, M.C., the President of the Branch. The Mayor of Lewisham (Councillor G. R. Bradfield, L.C.C.), and Mr. Arthur Skeffington (M.P. for West Lewisham), both Vice-Presidents of the Branch, were present with the Mayoress and many local officials of the Legion.

Obituary

Chairman of the Irthlingborough Gas Company for about 50 years until its amalgamation with the Wellingborough Gas Company, of which he remained a Director until his recent retirement, Mr. J. C. BRAMPTON, of Irthlingborough, has died at the age of 79. He was one of the town's oldest business men.

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The death has occurred of Mr. FRANKLIN THORP, of Whitefield, Lancs., aged 72, a leading figure in the gas industry for some years and President of the Manchester Junior Gas Association in 1910. He was made a Director of the family firm at Whitefield when it became a private limited company in 1911. On the Board of United Gas Industries for many years, Mr. Thorp was at the time of his death, Chairman of Thomas Thorp & Co., Ltd., and a Director of Begwaco Meter, Ltd., Farnworth, and of Victoria Smallman & Co. He leaves a widow and one son.

The death occurred on June 8 of Mr. R. H. DUXBURY, late Director, Engineer, Manager, and Secretary of the Southbank and Normanby Gas Company. He was educated at Manchester Grammar School, and subsequently served indentures and received technical training with the Oldham Corporation Gas Department. He also studied at the Manchester School of Technology, and the Salford Royal Institute, and was awarded the City and Guilds Bronze Medal for Gas Engineering in 1910. He was later appointed Assistant Manager of the Hollinwood Works at Oldham and Resident Manager of the Central Works. He was Assistant Engineer with the Longwood and Slaithwaite Gas Company for three and a half years, and for 10 years served as Engineer and Manager of the Batley Corporation Gas Department, prior to his appointment in 1928 at South Bank, from which he retired in April this year. A member of the Institution of Gas Engineers since 1920, he served on the Council of that body for three periods (1934-35 and 1938-41 as District Member and 1942-45 as Ordinary Member), and was President of the North of England Gas Managers' Association in 1934-35. After some years as Hon. Secretary of the Northern Region of the National Gas Council, he became Joint Hon. Secretary of the Northern Region of the National Gas Council, Federation of Gas Employers, and Joint Industrial Council, as well as of the Gas Advisory Board. He was also a member of the National Joint Industrial Council and of the Central Committee of the Federation of Gas Employers.

Diary

June 23.—**Gas Council, Coke Department :** Technical Coke Committee, Gas Industry House, 2.30 p.m.

June 24.—**Northern Junior Gas Association :** Annual General Meeting, Seaburn Hotel, Sunderland.

June 24.—**Waverley Association of Gas Managers:** Annual Meeting, Y.M.C.A. Hall, Edinburgh, 10.15 a.m.

June 25.—**Wales Junior Gas Association :** Summer Meeting.

June 25.—**Western Junior Gas Association :** Summer Meeting and Ladies' Day, Exeter. Inspection of Exeter Gasworks, 11 a.m. ; luncheon, Rougemont Hotel, 12.45 p.m. ; motor coach tour, 2 p.m.

June 28.—**Southern Association of Gas Engineers and Managers:** Summer Meeting, Taunton.

June 30.—**Gas Council, Coke Department :** Coke Committee, Gas Industry House, 11 a.m.

July 1.—**Manchester District Association of Gas Engineers:** President's Day, Blackburn.

July 13.—**National Benzole Association :** Annual Meeting, Wellington House, Buckingham Gate, S.W.1, 3.45 p.m.

Morley Town Council was informed on June 8 that 24 houses are to be erected on the Garden House Lane estate for key workers to be employed at the new central gas manufacturing station at Tingley.

The Trade Statistics for April, 1949, just issued by the Department of Industry and Commerce in the Republic of Ireland, show imports of 10,715 tons of gas coal, valued at £51,947 as against 17,882 tons valued at £85,202 in April, 1948. This brings the total of these imports for the first four months of 1949 to 65,446 tons, valued at £303,865 compared with 88,163 tons, valued at £385,444, for the corresponding period of 1948.

A New Window Display, designed to inform consumers of the boundaries of the new divisions as well as to emphasise the unfailing fuel service afforded by gas, is being placed by degrees in all the showrooms of the Warwickshire Division of the West Midlands Gas Board, and will also be placed in the Coventry Public Relations Office and in windows devoted to municipal propaganda. A feature of the display is a coat of arms, based on the 'bear and ragged staff' of Warwickshire.

The Annual Sports of the York, Harrogate Group of the North Eastern Gas Board were held in Harrogate on June 18, when over 400 members of the Group with their wives and families took part. The very full programme arranged by the Committee included races for young and old, and an inter-district Tug of War between York and Harrogate teams. Dr. R. S. Edwards, Chairman, North Eastern Gas Board, and Mrs. Edwards were present. Mr. A. McDonald, Member, North Eastern Gas Board, as President of the Sports Committee said that he welcomed the opportunity for inter-district competitions and he hoped that they would continue. Mrs. Edwards presented the prizes to the winners and was later presented with a bouquet. Mr. N. A. Walker, proposed a vote of thanks to Mrs. Edwards, and to the Committee for the excellent arrangements they had made, and called for cheers for Mr. F. W. Allum for the service he he had rendered at the microphone.